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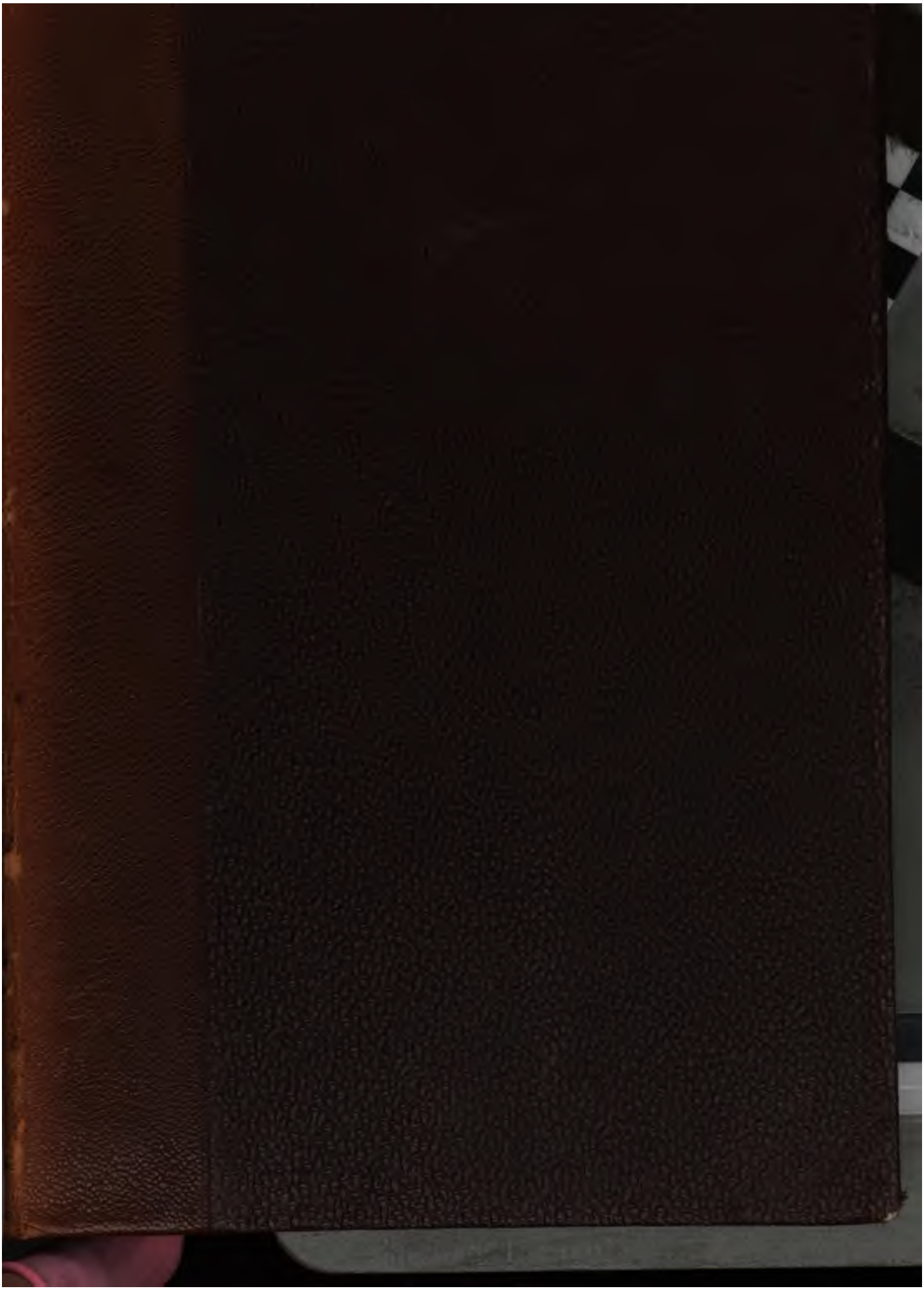

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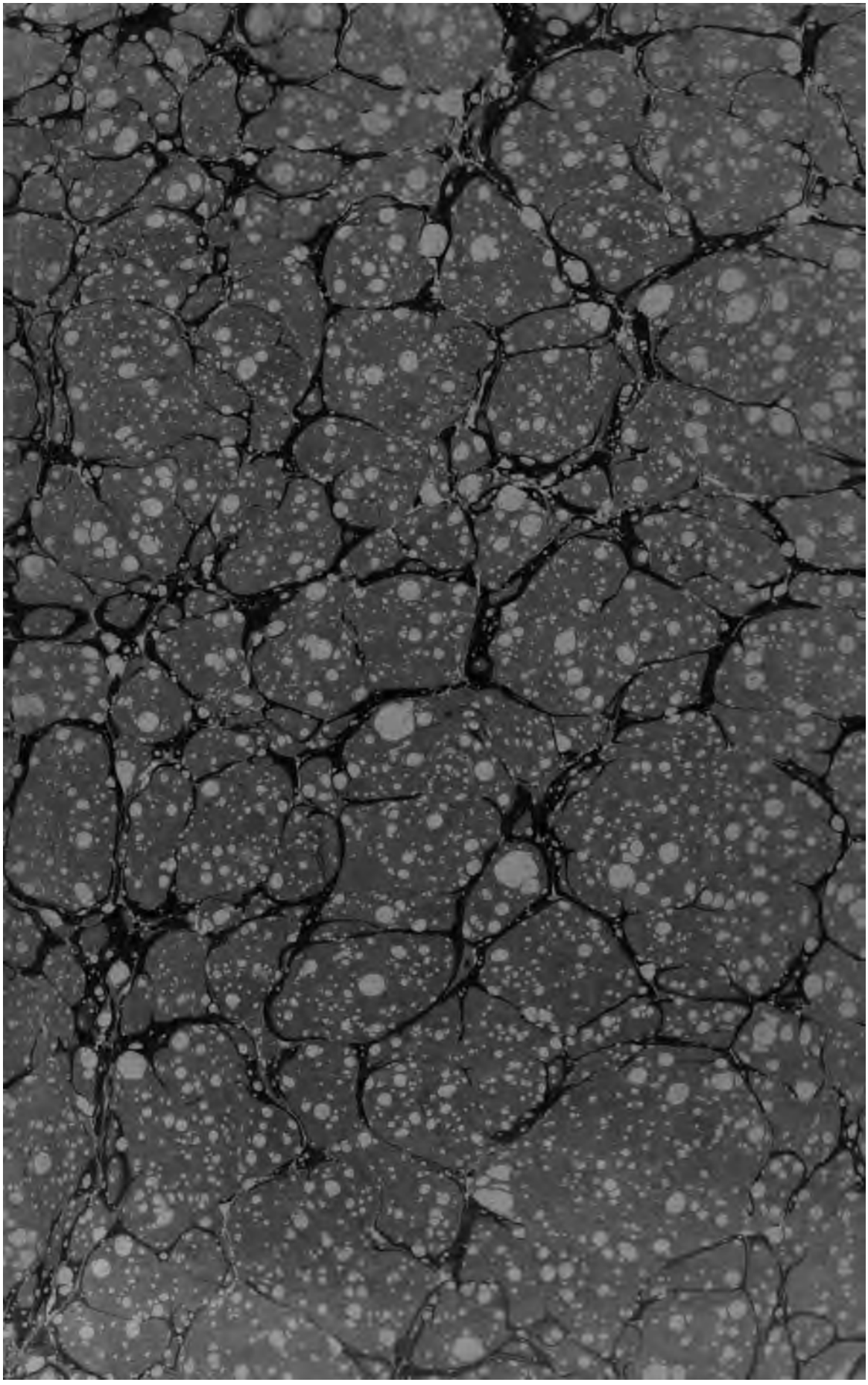

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NOTES ON THE DEVELOPMENT OF A CHILD

II

THE DEVELOPMENT OF THE SENSES IN THE FIRST THREE YEARS OF CHILDHOOD

BY

MILICENT WASHBURN SHINN

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BY

MILICENT WASHBURN SHINN

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EDITOR'S NOTE

The contents of this volume form a continuation of the studies by the same author, published in 1893–1899 under the title *Notes on the Development of a Child* as Volume 1 of the "University of California Studies."* This volume may be considered as forming Volume 2 of the *Notes on the Development of a Child*, although published as Volume 4 of the University of California Publications in Education. References herein to Volume 1 of the *Notes* are distinguished by the Roman numeral I preceding the page number.

* Now merged in the University of California Publications in Education.

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THE DEVELOPMENT OF THE SENSES IN THE FIRST THREE YEARS OF CHILDHOOD.

INTRODUCTION.

I. SOURCES AND PURPOSES OF THIS STUDY.

My original data for the following study have come almost entirely from a journal of the development of a single child, who was closely observed by me during the whole period of the record. But in the later examination of the data, I have supplemented them with the observations of others: indeed, I have at some points rested more on these than on my own,—either because at such points my notes were insufficient, or because the facts had been so well established already that my observations could do little more than corroborate. I have, therefore, incorporated in the course of the following study so much review of the work of others that I have not thought anything would be gained by prefixing here a summary of the literature of the subject, to define the status of knowledge from which my own inquiry sets out. So, too, I omit any special acknowledgments here of indebtedness for material and suggestions, because I shall have frequent occasion to render these in the course of the following pages.

My record was but little guided by any previously formulated theory, or by the effort to solve any previously formulated problem: I waited rather for the facts to define the questions as well as to suggest the answers. On a few specific points I formulated questions, and sought answers by experiment; but in the main, I aimed only at a scrupulously objective record of the facts of development, as they appeared quite spontaneously. In my own study of this large mass of biographical facts, I found it neces-

sary to group and regroup them, and to compare them over and over, in different aspects and in the light of different theories; but for purposes of presentation, it seemed to me most useful to gather them under topical divisions, such as were most simple and obvious, and most convenient for reference and comparison with the data reported by other observers; and to reserve my generalizations and inductions for separate presentation. I have, therefore, some time ago, gathered out all my data relating to the development of the senses, classified them, and published them, in several university studies (Notes on the Development of a Child, Numbers I–III, University of California Publications in Education, Vol. I, 1893–1899; in which is included also Number IV, 1899, containing data on the Instinctive Movements, since I found it impossible to consider the development of Sight and Touch apart from that of Grasping). In the following study I now offer my summary and interpretation of these published data,—to which I shall refer throughout, as an integral part of the present treatise.

It is the purpose of this interpretation to trace the development of the senses from stage to stage, with reference to the genetic relationship of these stages, and the process by which each unfolds from the preceding; to see if any general law of this unfolding can be detected; and to consider the bearing of any results thus reached on current problems of psychology. Finally, I formulate the pedagogical conclusions that seem to me suggested, —treating them rather as corollaries than as the objective point toward which the whole study is directed; and this not because I would put the pedagogical application of child-study in a place of secondary importance, but rather because I am convinced that pedagogy itself suffers from an attempt to bend our investigations directly to its service (especially in considering the period of infancy), at this stage of our knowledge. Child nurture already rests on an empiric basis which the very fact of the progress of the race shows to be on the whole sound; and to disturb a sound empiricism with the incomplete conclusions of a new science is dangerous. It is desirable that child psychology should make further advance as a pure science before it ventures

any but the most cautious incursions into the field of applied science.

II. METHODS IN CHILD-STUDY.

1. COMPARATIVE AND BIOGRAPHICAL METHODS.

In studying child development, one may select a definite point of inquiry, and obtain parallel data concerning it from a number of cases,—as Genzmer, for instance, tested some 20 infants for temperature sense by touching with an ice-cold iron rod; or one may keep a consecutive record of the process of development in a single child,—a method of which Prof. Preyer's work is the classical example. By these two methods, which may be called the comparative and the biographical, we have obtained all our important first-hand data for the study of childhood. It is true that fragmentary and unclassified observations, gathered from sundry sources, and compared by a competent student, have given rise to important studies; Prof. Sully, in especial, has classified and interpreted such data with singular felicity. But we cannot count this as a third method in direct child-study, for in the first-hand observations on which it depends there cannot be said to be a method at all.

When the number of observations is large enough, and the data simple and precise enough, to give value to arithmetical averages, the comparative method becomes a statistical one,[1] such as has been largely used in America by Pres. G. Stanley Hall, Dr. Arthur Macdonald, Prof. Barnes, and others. It is rarely possible, when the observations thus pass into the thousands, for the investigator to make them all himself, and in most cases statistical studies rest on data gathered either through assistants or by means of syllabi.

At first thought, the comparative method, especially when it is carried on to the extent and precision of statistics, seems the more scientific one. Conclusions cannot be securely drawn, it is felt, from observations on a single child: individual peculiarities might be mistaken for general traits of infancy. On the other hand, it is evident that the ontogenetic process, the unfolding of one stage of growth out of another, the evolution, in short, of the

[1] Dr. Macdonald gives this the name of the "collective method."

human being, cannot be traced except by watching the successive steps as they actually take place in one and the same child; and during the period of infancy, when this evolutionary process is going on with great clearness and rapidity, it is the most important object of inquiry.

Nor are the data obtained by the biographical method, at this period, wanting in general applicability. For the earliest years of life are mainly occupied with the great generic developments, common to the human race: the fundamental sense powers; the instinctive human types of movement and balancing of the body; the elementary processes of mind; the simplest and most universal forms of emotion. The possible range of individual variation is small, for all normal infants must come into possession of the same fundamental human powers, and by a course of unfolding that is essentially the same.

In respect to practical convenience, too, we are driven to the biographical method in studying children not yet out of the nursery; for comparative data about such little ones, isolated as they are in their several homes, are impossible to collect on any large scale. We have practically none except from physicians in maternity clinics, and these relate only to the newborn.

When we come to the study of older children, comparative data on a large, statistical scale are easily collected through the machinery of school organization, and at the same time the biographical method becomes more difficult in practice, and less useful in results. The observer cannot follow the child's life consecutively, divided as it is between home, school, and playground; the activities become too complex to be recorded; the evolutionary process becomes slower, and obscured by education and by individual variation; the mental life is more or less concealed by reticence. It comes about thus that almost all our studies of the child of school age are comparative, usually statistical, while those of the child in the nursery are biographical.

Yet it must be added that even in infants there is undoubtedly, within its range, a good deal of individual variation; and this variation is of the greatest importance, since it is the measure of the plasticity of our instincts. Moreover, even in case of a

process of development in which there can scarcely be any essential variation (as in acquiring the use of the eye in space measurement), the observer has to divine what that process really is from slight external indications, and these may vary much in different infants. Therefore, both to check our generalizations, and to get wider basis for interpretation, it is important that any biographical record should be compared throughout with other observations. And once more, there are certain starting-points of investigation (such as finding out the exact equipment in sensibility at birth), and certain positive determinations as to the presence or absence of a given power at a given stage (as of color vision in the first year),—questions where what is desired is to fix a detached phenomenon with a high degree of certainty and generality, rather than to follow out its genesis or its results, —in which comparative observations are indispensable. The biographical method, then, thoroughly checked and corrected by comparison, seems to be the true one for the study of children in the earliest period.

2. OBSERVATION AND EXPERIMENT.

This is a cross-classification, for whether the student uses the comparative or the biographical method, he can hardly dispense either with observation or with experiment. Still, experiment will be principally used with the comparative method, and pure observation with the biographical. For when one wishes to get evidence on a given point from a number of infants, he can rarely wait for the spontaneous occurrence of the particular reaction he is looking for; he must arrange conditions to bring it about. Moreover, for exact comparative results the conditions must be the same for each child, and this often requires artificial arrangement. Under the biographical method, on the contrary, where the main purpose is to follow the spontaneous process of development, experiment must be cautiously made, or it will interfere with the spontaneity. So long as tact is used, however, and the experimental conditions are closely in line with natural ones, there need be no such danger; and experiment is sometimes really necessary. When we desire to know, for in-

stance, whether the ability to follow a moving object with the eyes has appeared, it would be fatuous to wait for the chance occurrence of some object moving at the proper distance, in the proper direction, instead of providing one.

No doubt the possibilities of experiment with an infant are limited. Of modern experimental methods in psychology, that which depends on the subject's own introspection and report of his impressions is wholly excluded. We can use only experiments calculated to bring out reflex or sensori-motor responses to stimuli, and then depend on our own interpretations of the responses. Even this type of experiment is greatly restricted in practice by the child's frequent refusal to submit to conditions, and by the whimsical variations in his attention. Nevertheless, it is my impression that it might be used much more effectively in the nursery than has yet been recognized by psychologists.[2] Experiment with an infant requires a difficult change of mental attitude in the investigator accustomed to deal with the problems of adult psychology, and to adjust his expectation to adult habits of reaction. In the nursery, where the subject will not conform to the conditions of experiment, the conditions must be conformed to him; which calls for an attention to infantile whims that seems puerile to most scientific men. And not only has the laboratory psychologist a strange "psychological material" to deal with here, but he also finds himself in need of entirely new apparatus, so devised as to fall in naturally with the baby's daily activity, —such, for instance, as the device used by Prof. Baldwin to test the color sensibility of an eight-months' infant. The mere mechanical difficulty of getting suitable apparatus has been a real obstacle to the use of experiment in the nursery by women. These are difficulties due not so much to the nature of the study as to its novelty, and there is no reason why they should not be overcome.

Meanwhile, it is just as well that the subject should wait a

[2] Prof. Baldwin has already urged this method, which he names the "dynamogenetic," and calls "a new method in child-study;" it does not seem to differ, however, in any respect, from the method more or less systematically used ever since Kussmaul's tests of sensibility in the newborn, reported in 1859.

while for any considerable experimental investigation, and should depend for the present mainly on pure observation. The mass of facts easily to be gathered by intelligent observers without intensive research is still great, and the comparison and interpretation of such facts still inadequate; and until these are better surveyed and analyzed, we lack a sufficient inductive basis for theories to guide experiment.

It may be said that child-study is not a new science, but a branch of psychology, and should easily be directed by the theories of psychologists. Yet as a matter of fact, a deep knowledge of adult psychology has not hitherto proved so good a preparation as might have been expected for the study of infancy; and it remains true that the most solid and valuable contributions to our knowledge of babies, so far, have come not from psychologists, but from physiologists. In genetic psychology, indeed, it may be said that the genetic element outweighs the psychologic, —the conspicuous trait in its subject-matter is a plastic and developing condition, an instability and progressive change; and this is a condition long familiar and deeply interesting to the biological sciences, but only slightly so to psychology as yet. Again, in the absence of introspective self-consciousness in the infant, *mind,* as adult psychology knows it, scarcely exists; the whole type of reaction that must be studied, the whole type of interpretation that must be made, approximate to the purely physiological. On the other hand, the physiologist stops short of the real point of interest in child development, the germination of the higher psychic activities. Neither science at present gives a satisfactory theoretic basis for the study; which, therefore, seems to me to promise the best results if it builds up in the main its own theoretic basis, by (1) gathering a large mass of data by observation and limited experiment under guidance only of the broadest and most well-established principles of biology and psychology; (2) classifying, comparing, and drawing inductions from these facts; and (3) only then bringing them into relation with the more tentative theories of the sciences in question.

I realize that this doctrine would have the investigator end

where he is urged, by one of the most eminent students of genetic psychology, to begin;[3] and I do not fail to see the great loss, in guidance to attention, that the observer without a theory suffers. A theory formulated, a question framed, opens the eyes to the significance of facts that would otherwise have passed unnoticed. Yet it is no less true that it shuts the eyes to facts that fall outside the theory, and point off to unsuspected knowledge; and it is this rich suggestiveness of the facts themselves toward which we especially need to keep our minds plastic when entering on a new region of inquiry. Darwin's well-known words as to his own method are in point here, and seem applicable to the present status of infant psychology:—

> It occurred to me in 1837 that something might perhaps be made out on this question by patiently accumulating and reflecting on all sorts of facts which could possibly have any bearing on it. After five years' work, I allowed myself to speculate on the subject, and drew up some short notes; these I enlarged in 1844 into a sketch of the conclusions that then seemed to me probable; from that period to the present day [1859] I have steadily pursued the same object.

My own study (as I have said above) followed this method of observation and later induction; and even when interpretations foreshadowed themselves to my mind while I watched the process of development, I held them in abeyance till I could make full comparative analysis of everything in my notes that bore on the question, and could also examine the data of other observers, and the psychological discussions that seemed relevant. I fell upon this method more by accident than by deliberate choice: yet I have not regretted it. I have sometimes found when too late that

[3] "Only the psychologist can 'observe' the child, and he must be so saturated with his information and his theories that the conduct of the child becomes instinct with meaning for his theories of mind and body. . . . That most vicious and Philistine attempt in some quarters to put science in the strait-jacket of barren observation, to draw the life-blood of all science—speculative advance into the secrets of things—this ultra-positivistic cry has come here as everywhere else, and put a ban upon theory. On the contrary, give us theories, theories, always theories! Let every man who has a theory pronounce his theory. . . . In the matter of experimenting with children, therefore, our theories must guide our work." James Mark Baldwin, Mental Development in the Child and the Race: Methods and Processes, pp. 36, 38.

for lack of a definite theory I have completely overlooked some aspect of development that I should have wished to observe, or left some point doubtful that a well-arranged experiment would have settled; but I have oftener found that where I had used extreme care to record with accuracy and fulness the actual occurrences, even where they seemed to have no significance, an unexpected significance would start out later, when I came to compare widely separated items in the record; and the fact that the interpretation thus formulated itself, so to speak, without prepossession on the part of the observer, seemed to me to give it greater weight.

The older the child grows, the more the study of his mental development ranges itself under the ordinary conditions of psychological research. And even as regards the earlier period, I speak only of the present conditions of the study, and would by no means exclude the possibility, at any moment, of some epoch-making work which shall supply the lacking theoretic basis, and direct future observations along the most profitable lines. Prof. Baldwin's important book[4] has failed to do this service, and has left the study of early childhood essentially where Preyer placed it, because it has, after all, no close practical relation to that study: its motive is not so much a working basis for the study of genetic psychology as a genetic theory of mind and personality.

3. PRINCIPLE OF CLASSIFICATION.

When we pass from the consideration of collecting data to that of studying and presenting them, we come at once to the need of some theoretic basis, however general,—some guiding principle, according to which the facts shall be brought into groups for comparison and induction. In the case of data obtained by the comparative method, of course, this basis is already at hand in the original inquiry which directed the observation; so too when data from miscellaneous original sources are brought together into a specific comparative study. But when one wishes to organize the facts given by a biographical record, or to make out from data of all sorts a *general* review of the field of child devel-

[4] Mental Development in the Child and the Race, New York, 1895.

opment, the question of a basis of comparison becomes more difficult. No practical method has so far been found except that of a topical arrangement under the different categories of human faculty.[5] It is probable that no one has found the method satisfactory. The infant's faculties do not develop, one by one, along separate parallel lines: they begin early to enter into so intimate combination that it is impossible to trace the development of one apart from that of another. Shall we treat a new stage in the control of the eye muscles under the head of Will, of Vision, or of Association? It may be an essential chapter in the history of each of the three. When a baby shows by grasping movements an estimate of size and distance, shall we assign the incident to our section on Sight, Touch, Muscle Sense, Association, Inference, Movement, or Desire? to Intellect, Will, or Emotion? Nor does the difficulty come from the use of these particular categories. Should we abandon them for a physiological classification, say, and divide our material into chapters on the Centripetal, Central, and Centrifugal activities, we should meet the same difficulty. Every entry in the record would come under all these heads. There is no possible classification under analytic headings that does not dismember every incident we would re-

[5] Following are the classifications used in the four classified general biographies, and in Tracy's review of child psychology:

TABLE I.

Preyer.	Sully.	Hall.	Moore.	Tracy.
I. Senses (under which are classed Emotions).	I. Intellect (under which Sensation).	I. Physical development (under which Movements).	I. Movements.	I. Sensation.
II. Will (under which Movements).	II. Emotions.	II. Psychical developments. 1. Senses. 2. Emotions. 3. Intellect (under which Language).	II. Sensations.	II. Emotion.
III. Intellect (under which Language).	III. Will.		III. Ideas.	III. Intellect.
			IV. Language.	IV. Volition.
				V. Language.

port; for the actual development we are trying to trace is essentially synthetic.

Yet we must needs analyze, in order to interpret. A chronological presentation of facts, narrating a child's development as it actually occurred, as a whole, would bring us no further than the mere observation did. The chronological order of events must be broken into in studying their significance, for we constantly find the infant's action of one day—expressing as it does some incipient phase of development—meaningless and trivial till it is illuminated by some other action, days or weeks after: bits of the mosaic from far apart have to be fitted together before it is intelligible. Nor can one fail to see that though it is true the child does not develop faculty by faculty, independently, yet these different types of life-activity are from the first and at every stage distinct in him, and must be studied separately. Our subject, in fact, by its nature, demands at once the following of a complex progressive movement in time, and the analysis of the changing complex, stage by stage, into its elements.

One is tempted by the ideal of a treatment based on the chronological order, but pausing as it goes to disentangle each thread of development, tracing week by week the separate advance of each power, and also the interplay of powers, the fusion of simpler activities into more complex, and the differentiation of specialized ones out of generalized, never losing sight of the developing whole, the child. Such a presentation must remain an ideal only: even had we complete enough knowledge for it, the mass of apparently trivial details could never be managed in such a complicated treatment. Yet we have in this ideal a suggestion of the principle that should guide our classification. For it is evident that if such a treatment were practicable, we should have when it was done no new method, but only an alternation, paragraph by paragraph, of topical analysis with biographical narrative,—brought into a unified whole by the guiding idea of *a progressive movement consisting of the integration of simpler activities into more complex, and the differentiation of specialized ones out of generalized.* And under whatever alternation

we find it convenient to turn from one to the other of these methods,—paragraph, chapter, or treatise,—we shall have essentially the same treatment, so long as the guiding idea I have just emphasized is the real organizing principle.

I do not here discuss the validity of this principle—the question whether the significant trait of development in infancy really is this progressive integration and differentiation—because the most important part of the following thesis is a contribution to that very discussion. I may say here that I reached it inductively, as the principal generalization based on my own observations; and that its agreement with the analytic results of several psychologists (notably Wundt) concerning the genesis of complex faculties by the fusion of simpler ones in infancy, as well as the precision with which it ranges itself under the Spencerian definition of a true evolutionary movement, was unexpected to me.[6]

III. ANTICIPATION OF CONCLUSIONS.

The general conclusions that I find indicated by the discussions which follow, are, in brief:—

I. The child is at birth capable of receiving impressions in every department of sense (unless for a short delay in the case of hearing). These impressions are feeble, but have from the first the quality of pleasantness or unpleasantness, and to a certain extent at least their own specific qualities, so that they give varied experience. But the sense condition differs totally from that of the adult, in that central connections are wanting; each sensation is a wholly isolated experience; there can be no proper perception, discrimination, or recognition, no consciousness of space, of objects, or of externality.

[6] Since this thesis was approved (in a form essentially the same as now published), I have embodied my view of the essential process of development in the first year of infancy in a sketch, called The Biography of a Baby, printed in *The Puritan*, in 1899–1900, and in book form by Houghton, Mifflin & Co., in 1900; and during the publication of these papers, I was interested to find almost exactly my own view of the true principle of classification distinctly formulated by Prof. Dewey, in a publication of the Illinois Child-Study Society (1897, II, 17–27).

II. The development of the senses after birth consists somewhat in increasing intensity and variety of sensation within the several departments of sense, but more in the synthesis of sense presentations from different departments, producing a perception of space and of objects as such; in interpretations, especially the elementary ones of size, distance, and form; in the association of sense experiences with voluntary movements, so that the organs can be deliberately adjusted to seek the experiences by looking, listening, feeling, etc.; and in recognition and discrimination.[1] That is, physiologically speaking, it consists mainly in the development of the central associative connections.

III. The sense condition at birth does not correspond to any primitive phylogenetic stage, nor does the development of the senses follow the phylogenetic parallel in the main, though some specific phases of development show such correspondence.

IV. The psychic life of the child centers from the first about the higher senses, especially sight, not the lower. Sight, touch, and the feelings connected with muscular activity make up the bulk of the conscious life, until hearing comes to great importance with the beginning of speech. Taste and still more smell are late in development, and of minor importance. But the organic sensations, though in the background of consciousness, have most important relation to the development of the feeling of self, and to the emotions,—relations that can merely be touched on within the limitations of this essay.

V. The pedagogy of the senses in the first three years should consist mainly in carefully affording the freest opportunity for instinctive development. But deliberate education cannot be altogether dispensed with. The enjoyment of music, the understanding of pictures, and the recognition of colors and plane forms, are the directions in which formal teaching of the senses has shown the best results in this early period.

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[1] The representative processes, in all this development, follow close at the heels of the presentative, and are involved most intimately with them in every stage after the first. To consider their nature and growth, however, would carry me too far beyond the scope of this essay; the representative element is therefore taken for granted, noted by its results only, in the complex stages of sense development which I try to trace.

I add a few specific conclusions, which seem important enough to justify the emphasis:—

1. Glitter and chiaroscuro interest earlier and more than color. Plane form is discriminated earlier, and interests more, than color. The first picture books should be in black and white outline.

No certain evidence has been found of the existence of full color perception till well on in the second year, but I found it completely developed by the last quarter of that year.

2. The mouth is at first the chief organ of touch and prehension, and is preferred for touch months after the hand has taken its place in prehension. It is for purposes of touch, not on account of taste associations, that objects are so persistently carried to the mouth.

3. In the development of color perceptions, and in the relation of mouth and hand to touch and prehension, there are strong indications of a parallel between ontogeny and phylogeny.

4. Especially sensitive conditions of general sensation attend the oncoming of sleep, and still more the awakening, and have a marked relation to emotional development.

PART I. SENSIBILITY OF THE NEWBORN.

In this part of my treatise I have scarcely anything original to offer: partly because my observations were scanty, and partly because the ground has already been so fully investigated by others.

The subject was early brought into discussion—as early at least as the time of Locke—in connection with the metaphysical question whether any ideas exist before experience has been received through the senses; and one may glean a good many expressions of opinion about it from writers of the late eighteenth century and the first half of the nineteenth,—expressions of opinion, not recorded data of observation, for at this period there was a wholly inadequate idea of the difficulty of the questions of fact involved, and no one seems to have suspected that ordinary casual knowledge of the ways of infants was not sufficient basis for judging the real condition of their senses. Still, these early notices, though of little value as scientific data, had an important influence in hastening careful study of the sensibility of the newborn. They brought distinctly forward the problems: "At what date does the human being begin to receive sense impressions,—after birth, at the moment of birth, or in prenatal life?" and, "In what order do the different sensations appear?" They called attention to the fact that we are not to assume lightly that an infant's state of consciousness on receiving a given stimulus is the same as our own. And their very contradictions and uncertainty emphasized the need of accurate special observations on the subject.[1]

[1] Kussmaul prefixes to his own study a number of citations from earlier writers concerning the time and order of appearance of sensations. A tabulation of these views (to which I add those of Löbisch), up to the date of Sigismund's Kind und Welt, will give an idea of the confusion of mind that prevailed, as late as the middle of the nineteenth century, on a matter so close at hand, and of so intimate human interest and scientific importance.

With Sigismund's "Kind und Welt"[2] (1856) we have the

TABLE II.

EARLY VIEWS ON THE ORDER OF APPEARANCE OF SENSATIONS.

Writer.	Time of Appearance of the Sensation.		
	Prenatal.	Immediately After Birth.	Later.
Locke, 1791.		Hunger and feeling of warmth.	1. Sight (sense of light). Order after this hard to fix.
Erasmus Darwin, 1793.	Feeling (sensations of position, muscular activity, touch).	Sight, hearing, smell.	
Bichat, 1800.		All the senses, but giving unspecialized sensations (*e. g.*, taste only, no specific tastes).	
Cabanis, 1802.	Touch, and organic sensation.	Imperfect taste, sight and hearing.	Smell.
Carus, 1808.		Touch-smell, undifferentiated.	1. Taste. 2. Hearing (at about 3 weeks). 3. Sight (5th or 6th week).
Rudolphi, 1823.			Taste, sight, smell, all absent in the newborn. Smell much the latest.
Löbisch, 1851.		General sensation.	1. Sight and passive feeling. 2. Hearing and taste. 3. Smell and touch.
Bautain, 1853.		Sight.	1. Taste. 2. Smell. 3. Hearing (not for several months).
Burdach, 1854.		Sight, and general feeling.	1. Hearing and taste. 2. Smell and touch.

[2] Kind und Welt, Berthold Sigismund, Braunschweig, 1856. Mit Einleitung und Anmerkungen neu herausgegeben von Chr. Ufer. Braunschweig, 1897.

beginning[3] of careful observation, in a newly scientific spirit,—although on this especial topic, the beginning of sensibility, Sigismund contributes little. In 1859, however, Kussmaul[4] published the results of extended special investigations upon the condition of sensibility at birth, made in a maternity hospital; and the investigations were repeated by Genzmer[5] (1873), and Kroner[6] (1882). These successive investigations have settled beyond question the main objective facts as to the reactions of newborn infants to sense stimuli. As far as these facts are concerned, therefore, the following chapters must needs be little more than a re-statement of what was already well established, with but a few minor contributions toward our more precise knowledge of the extent and variety of responsiveness within the several departments of sense.

As to the *interpretation* of the objective facts, however,—the effort to determine what kind and degree of sensation, what psychic life, is indicated by the observed reactions,—we are far from any certainty; and it is for the sake of re-examining the data available, and offering my own interpretation of them, that this part of my thesis is written, in spite of its meagerness in original material.

[3] The beginning as far as practical influence on readers was concerned: Darwin's admirable observations were made long before (in 1840), but were not published till 1873 and 1877. Tiedemann's, which as Ufer says, "come properly into comparison with Sigismund's in respect to method," and whose date he fixes at last as 1787, fell so absolutely out of sight that until within the last decade bibliographers could not trace it further back than a French translation of 1863; it was evidently unknown to Sigismund and to his immediate successors. We have evidence of the existence of a treatise that seems to have been based on observation, even before Tiedemann; viz., Lettres et Observations sur la Vue des Enfants Naissants, Desmonceaux, 1775. Kussmaul, who had not himself seen it, cites a citation made from it by Rudolphi, in 1823. I do not find it in any bibliography, nor does any recent writer seem to have seen it. It would certainly be interesting to recover this paper, pioneer of all pioneers in the field.

[4] Untersuchungen über das Seelenleben des neugeborenen Menschen. Adolf Kussmaul, Leipzig, 1859.

[5] Untersuchungen über die Sinneswahrnehmungen des neugeborenen Menschen. Alfred Genzmer, Halle, 1882 (first published as an Inauguraldissertation, 1873).

[6] Ueber die Sinnesempfindungen der Neugeborenen. Traugott Kroner, Breslau, 1882.

The question may be raised here: How far can we assume that the motor reactions observed in the newborn infant indicate psychic life at all? Up to the time that some evidence of voluntary action appears, is it not possible that the arc of stimulus and reaction is completed through lower brain-centers, unconnected with consciousness? It is not possible to make any general answer to this question. Consciousness can scarcely be an essential part of the process in any of the movements of the newborn, since it is quite well agreed that these movements are wholly automatic in type:[7] it must be at best a mere bystander, taking notes for future use; and it is quite possible that some reactions which we are accustomed to associate with consciousness do take place without it in the newborn infant (pp. 23, n. 18; 34; 40). But the evidence for its presence or absence differs in the case of each department of sense, each type of reaction, and must be examined in detail in the chapters that follow.

This is the place, however, to state generally the sort of evidence on which I rely in determining whether sensation is really present or not. There are two considerations which seem to me conclusive:—

1. Where we see in the reactions good evidence of *pleasure or discomfort,* we are not justified in doubting that an experience, pleasant or unpleasant, has been received. It is true that specific reactions (tending to guard against what is harmful to the organism, or to seek what is beneficial) might bear to our eyes all the appearance of expressions of liking and dislike, and yet

[7] W. Preyer, The Mind of the Child: The Senses and the Will (New York, 1892), Chaps. VIII–XI, XV; Mental Development in the Child (New York, 1895), Chap. IV. Cf. also Vol. I of this series, p. 397, *et seq.*, and my The Biography of a Baby, Chap. II; and Tracy, The Psychology of Childhood (Boston, 1897), pp. 90–92. Anatomically, also, the possibility of voluntary action has seemed to be excluded, since the voluntary motor paths from the cerebral cortex were thought to be not yet functional in the newborn infant. Flechsig's later investigation dates the first medullation of these paths *about* the time of birth (Gehirn und Seele, Leipzig, 1896, p. 64): still, the motor impulses proceeding down them could not be of truly voluntary type till memory, desire, and choice had come into play, through repeated experiences. Nor has any more appearance of voluntary action been reported in children born at full time than in premature children, in whom the pyramidal paths are undoubtedly still undeveloped.

be excited wholly without consciousness. But the less direct and specific the reaction in relation to its stimulus,—the more wholly it consists of those diffused and sometimes very subtle movements which in our own case are associated *not with this or that specific stimulus, but with agreeable or disagreeable feeling, due to stimuli of all sorts,* and which have never been detected in cases where there was a strong presumption against the presence of consciousness,—the more reasonable it is to believe that the infant feels, as we do. Thus when the application of quinine to the ends of the taste nerves draws the child's face into what we recognize as the expression of "bitter" sensation, and yet no general signs of discomfort are given, we are justified in doubting whether a true taste sensation has been experienced. When the local reaction is followed by restless movements of arms and legs, and perhaps crying, it becomes far more difficult to doubt that the baby has really tasted bitter and found it unpleasant; yet if these signs followed on an intensification of the stimulus, it is still possible to urge that they may be merely due to a widening of the motor area affected by it, an overflow and diffusion of its purely physiological effect, and may not express discomfort at all. But where the emotional reactions occur *without* the local, defensive ones (where the baby makes a crying face instead of a "bitter" one, *e. g.*), or where the diffused signs of comfort or discomfort occur when the stimulus has not been abnormally intensive, and so not likely to overflow its normal local effect,—in such cases, to question the presence of real feeling, with pleasant and unpleasant quality, would be a pedantic skepticism. No observer of merit has ever raised such a doubt.

2. The evidence from *brain anatomy* is of the utmost importance. If the sensory impulses find functional conducting paths to the highest sensory centers, those of the cerebral cortex, we can have no reason to doubt that feelings of like quality with our own are associated with the central discharge; if, on the contrary, the impulses can pass no higher than the primary centers, in spinal cord, medulla oblongata, or cerebral ganglia, we can only conjecture as best we may, from the evidence of human pathology and that of experiments on the lower animals, how much con-

sciousness may or may not be associated with these centers. At the time that Preyer's great study was made, anatomists had found no evidence that any paths within the cerebral hemispheres were functional at birth. Professor Preyer, therefore (believing wholly, as he did, from the evidence of the infant's behavior, that sensations could be experienced in every department of sense, soon after birth), held that "there are several grades of consciousness, lower and higher, which have different seats,—in the higher animals particularly in the spinal marrow, cervical marrow, and brain";[8] and the higher consciousness he denies to the newborn child. This position is full of perplexities; and the whole matter is cleared up wonderfully by Flechsig's recent discovery that the cerebral cortex and paths are not wholly undeveloped at birth. According to his researches, there is every anatomical reason to suppose that a limited number of impulses can in fact penetrate to the highest sense centers, and that a number of the reflexes observed in the newborn infant are of cortical origin.[9]

Where we find the child, then, behaving as if it felt a sense-impression, and when it is known to be anatomically possible that this impression should reach the highest sense centers, we have twofold evidence, which gives us practical certainty of the presence of sensations like our own.

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[8] Mental Development in the Child, p. 155. See also The Senses and the Will, p. 70.

[9] It may be objected that this whole argument rests too confidently on the assumption that the date of functional capacity in a nerve-path can be fixed by the appearance of the medullary sheath, as if it were never possible for a neuron to transmit impulses without this sheath. It is well known that medullation is not, in itself, essential to function; but where its absence is due (as in the cerebrum of the newborn infant) to the *immaturity* of the neuron, we cannot suppose that the latter is as yet ready to carry impulses (Donaldson, The Growth of the Brain, London and New York, 1897, p. 234). Or if any impulses *could* make their way along the undeveloped, uninsulated paths, to the still more immature cortical cells, they could scarcely excite true sensations, with definite specific qualities; the infant would experience, over and above any few faint definite sensations, a much greater mass of confused and vague feeling—a condition that is not indicated by his behavior (see General Sensation, p. 45).

I. VISUAL SENSIBILITY.

1. SENSIBILITY TO LIGHT.

The child that I observed seemed from the first hour to feel a mild light agreeably (I, p. 10).*

That all normal children do react to the stimulus of light. immediately after birth, was already well established. The testimony of observers is practically unanimous.[10] In every one of the numerous cases tested by Kussmaul, Genzmer, and Kroner, the pupil was found to narrow and widen in response to changes of light, and the lids to close convulsively against dazzling light. Preyer says that he never saw a normal newborn child bear dazzling light quietly with open eyes.[11]

These defensive reactions, while they prove the sensibility of the retina, do not tend to confirm my impression that light is felt *agreeably* at the first. In the case of his own boy, however, Preyer found that long before the close of the first day the little face took on suddenly a less contented expression when the dim light of the window was shut off from the eyes. It is evidently a question of the intensity of the stimulus. The retina of the newborn can bear but a small quantity of light. The pupil, Preyer has observed,[12] is more contracted than in adults; the lids open by but a narrow slit,[13] and yet with all this pro-

* References thus given are to the author's Notes on the Development of a Child, this series, Volume I.

[10] Cuignet, as quoted by Genzmer, says that the two children he observed spent the first day in continuous sleep, and does not record the reaction to light till the second day; but this, of course, means simply that no opportunity was found to make the observation on the first day, not that negative results were obtained. Mrs. Moore (The Mental Development of a Child, Kathleen Carter Moore, New York, 1896) says that in the case of her boy, the pupils on exposure to light on the first day, showed "little alteration."

[11] The Senses.and the Will, p. 5. Cf. also Garbini, Evoluzione del Senso Cromatico nel Infanzia (Firenze, 1894), p. 12; and Mrs. Hall, First 500 Days of a Child's Life (The Child-Study Monthly, 1896–1897, Chicago. Vol. II), p. 458. Mrs. Hall saw contraction of the *brows* against bright light.

[12] The Senses and the Will, p. 4.

[13] *Op. cit.*, p. 2; cf. also Mrs. Moore, *op. cit.*, p. 51; and my The Biography of a Baby, p. 79.

vision for limiting the admission of light, defensive reactions quickly occur against an illumination that is at all brilliant, or even against a moderate one when the pupil has been expanded by darkness.[14]

The quantity of light that the retina can receive with comfort seems to increase day by day, and almost all observers mention the infant's contented staring at the window, the lamp, etc., during the first fortnight; or even turning his face persistently toward the lighter side of the room;[15] in some instances crying when light is withdrawn.[16]

It is well established, then, that in the newborn infant, the following reactions to light take place:—

1. In all normal infants, on the first day, defensive contractions of iris, lids, and sometimes brows, against bright light.

2. In all normal infants, on the first day or soon after, a general expression and behavior of contentment in mild light, and sometimes of discontent at its withdrawal.

3. In many infants, on the first day or soon after, reflex seeking movements toward the light.

That these reactions are accompanied by *sensations* of light, agreeable and disagreeable (as I have assumed throughout the foregoing paragraphs), is not to be doubted. Even if the simple defensive and seeking reactions might take place without consciousness of the stimulus, we have the stronger evidence of those more complex and refined ones that make up a facial expression and general behavior of content and discontent (p. 19, above). And the presumption raised by the infant's behavior is confirmed in the most decisive manner by brain anatomy, since Flechsig's

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[14] Preyer, *op. cit.*, p. 6; cf. also Champney's Notes on an Infant, p. 42 of the Talbot papers (Papers on Infant Development, edited by Mrs. Emily Talbot, Boston, 1882); and I, p. 10, of this series.

[15] This movement I was not able to see; but that it does often occur in the early days of life is thoroughly established. Sigismund, Kussmaul, Genzmer, and Kroner all report it, and Preyer found it "the rule" with his child by the 6th day. One of the contributors to the Talbot papers saw it as early as the 1st day (Case C, Papers on Infant Development), and Kussmaul on the 2d.

[16] Preyer, *op. cit.*, p. 3; Garbini, *op. cit.*, p. 14; Daniels, MS. record.

announcement[17] that conducting paths from the retina as far as the cerebral cortex are found medullated and ready to function in the fully matured fœtus at birth. We could not look for more complete evidence (in the absence of a report from introspection) that the normal newborn infant feels the specific sensation of light, with agreeable and disagreeable quality, just as we do.[18]

2. SENSIBILITY TO COLOR.

I was not able to find any indication whatever of sensibility to color within the first three weeks. Even after sensibility to light was conspicuous, the most brilliant field of color produced no reaction whatever (I, p. 25).

This is absolutely in accord with the reports of all observers

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[17] Ueber die Associationscentren des Menschlichen Gehirns. Proceedings International Congress of Psychology, 1896, p. 53.

[18] The question whether the reflex circuit through the lower visual centers alone might involve consciousness of light, is one with which we do not need to perplex ourselves, in the case of the normal infant, born at full time. But the case is somewhat different as regards prematurely born children. Kussmaul saw the reflex turning of the head toward light on the 2d day, in a child born in the seventh month, and Genzmer an adjustment of the pupil to light in one born in the eighth month. But Flechsig states that up to the close of the eighth fœtal month the paths from the retina to the cortex are still unmedullated. There is a certain presumption from this that these reactions can take place without consciousness of light, since it is well known that in the older human being there is no light sensation whatever when the cortical center of vision is destroyed. It is, of course, possible that the condition of the infant's lower centers, before the higher have developed, may be more like those of the lower mammals than like those of the adult human being, and therefore capable of mediating some visual consciousness, as seemed to be the case with Goltz's dog. Or it is possible that individual differences exist, and that in some infants the visual paths to the cortex are medullated earlier than in the cases examined by Flechsig. As our present knowledge stands, it is certainly doubtful whether any sensation of light is experienced at first by the prematurely born infant. Flechsig reports, however, that in such infants the cerebral paths become medullated with much greater rapidity, under the influence of external stimulus, than would have taken place under normal conditions, and that they are complete some time before the ordinary time of birth. (Gehirn und Seele, p. 53.)

who have given attention to the question of color.[19] In the present state of our knowledge of the physiology of color vision, it is hardly possible to get any evidence from anatomy as to its presence or absence. But we are justified in concluding from the total absence of reactions to color that it is not seen by the young infant; and this presumption is strengthened by the doubtful nature of all the indications of color sense for months afterward (see chapter on Color Sense, below). It is worth recalling, too, how small is the *quantity* of light admitted to the retina of the newborn infant (p. 21),—possibly not enough to give chromatic sensations in any case.

3. ADJUSTMENT OF EYE, AND TRUE SEEING.

It is evident that there can be no real seeing of objects without an elaborate system of co-ordinated movements, by which the eye is directed to the object, and over and about it to take cognizance of its form, and the lenses are adjusted to its distance. Of such movements I saw no rudiment in the first fortnight. The eyes rolled about almost incessantly, in those vague movements which I have called "spontaneous," and have attributed (following Preyer) to mere random overflow of motor stimulus, disengaged by the processes of growth in the centers (I, pp. 180, 299); they were directed to nothing, followed nothing, dwelt on nothing. There was, it is true, a prevalence of symmetrical movement of the two eyes, but there would naturally be an inherited tendency to this, even in the most random movement (I, p. 299). There has just been reported to me by Mrs. Chapman, whose scanty but careful observations I have quoted several times before from her MS. notes, the case of a child born in the seventh month, in whom, therefore, the ability even to see light is doubtful (p. 23, note 18), whose eye movements are remarkably symmetrical. Professor Preyer satisfied him-

[19] Genzmer conjectures that the newborn child receives "no sharp light images, but only general impressions of lightness, darkness, and color." The conjecture seems to have been without evidence as regards color, however; and in his later observations on his own child, he could get no indication whatever of color sensibility before the child was four months old. *Op. cit.*, pp. 23, 24.

self that in this tendency of the eyes to move in approximate unison in the earliest period,—a tendency constantly violated by highly asymmetrical movements,—there is no real co-ordination for visual purposes.[20]

That there is at this time no seeing of objects, that vision is, as Kussmaul says, "only a dull sense of light and dark, something such as the mole has if he finds himself above-ground," all observers, so far as I know, agree positively. Very few have been able to find, within the first week at least, any sort of fixation, any rudiment of progress toward adjustment of the eye, even so much as a persistent staring at a bright surface placed in the line of sight.[21] But there are two important exceptions to this rule, which tend to show that the apparatus for some of the visual adjustments is ready in the new born, and can be brought into reflex activity:—

1. Genzmer succeeded in inducing an apparent fixation and following movements with the eyes, and even with the head, as early as the 2d day of life, by holding a glittering key-ring, constantly shaken, before the eyes. That is, by applying a strong stimulus of light slightly at one side of the center of the visual field, the eyes can be made to turn so as to bring the high light to the center of the field. I find contradictory statements from physiologists as to whether the fovea takes on its special characteristics until after birth; but if there does exist a ready-made, inherited reflex by which the turning movement occurs upon the proper stimulus, it would take place in any case, whether better seeing was to be had thereby or not. Genzmer's observation is confirmed by two or three mothers' records (p. 60), but is in opposition to the results of such observers as Preyer, Kroner, and Raehlmann, who could get no following movements for weeks. Genzmer himself failed when he used a candle, and thought that the key-ring, constantly shaken, produced a dazzling effect that supplied a stronger stimulus. In any case, no such

[20] The Senses and the Will, pp. 34–41.

[21] Prof. Sully reports a fixed gaze on the 2d day; and Tiedemann thought that his boy's eyes at the same age were drawn toward objects in motion.

movements have ever been reported in the first week except under strong artificial stimulus.

2. Quite different in this last respect is the turning of the *face* toward the light, which I have already mentioned (p. 22),—a movement that makes its appearance under no other stimulus than the ordinary light of the room, falling unequally from one side. It has evidently the same object as the eye-movement; viz., to bring the highest light to the center instead of the more peripheral parts of the retina; and it seems to be indicated as the more primitive and easy way to do this by the fact that it appears in so many children, and without extraordinary stimulus. It does not appear in nearly all, however (p. 22, note 15), and plays no part as a regular stage in the development of the power of directing the gaze, but fades away as the control over the eye-movements increases,—or rather, becomes subsidiary to those movements.

It gives an impression of voluntary *seeking* of light that has been hard for observers to resist,[22] but there is really no more

[22] Thus Kussmaul concluded that light already "awakened a feeling of pleasure, and caused the child to seek it"; and Kroner says that the newborn keep turning the head "with preference" toward the light. And though Preyer says that the movement "cannot be regarded as a voluntary direction of the gaze," he goes on to explain it as "a case of desire in a primitive form": "Such and such a position of the body or the head is associated with an agreeable sensation"—that of light—"and is therefore preferred; another position, a disagreeable one, in which the face is shaded, is avoided." (The Senses and the Will, p. 2.) Such an explanation assumes a voluntary control, if not over the direction of the gaze, certainly over the positions of head and neck, which is quite at variance with all we know—with all that Prof. Preyer himself holds elsewhere—as to the type of movement in the newborn. Nor does it seem possible that an association can be formed so early between the sensation of light and the various dermal and muscular and other sensations that make up the feeling of position. I could not detect any sign of a fixed association before the 4th week; and we should not expect one to appear any earlier, from what we know of brain structure at this period (p. 47).

Sigismund, on the other hand, long before, noted the primitive and automatic character of the movement: "The eye of the nursling soon seeks the place where the light glimmers through the curtains, but in a way to give the observer the impression that it is quite involuntary and passive, as when the plant turns itself toward the light." So also Genzmer, more technically, holds that we have in this apparent seeking, "the be-

difficulty in supposing that an old reflex arc exists between the retina and the neck muscles than in recognizing one between retina and eyelids. It has not the precision and invariableness of a well-established reflex, but we are obliged to recognize in the infant a number of movements that can be accounted for only as imperfect and unstable reflexes,—survivals of ancient forms of action, now superseded by more useful ones, or broken up by the necessity of more varied and voluntary action; or, on the other hand, of forms of action that never became quite serviceable enough to be firmly fixed in the nervous system. A good instance of such survivals is the reflex hand-clasping of the young infant, which fades out as soon as voluntary clasping is developed. There is throughout life a slight involuntary tendency to turn the face toward light that falls sidelong; and possibly in the entire absence of inhibitions this might appear as a distinct reflex movement. The fact that Kussmaul saw this reaction on the 2d day, in a child born before the close of the seventh month, is strong testimony to its wholly automatic, if not unconscious, character (p. 23, note 18).

Even in a fully-developed newborn child, the increased distinctness of vision obtained by the movement can be hardly more, as has been said, than we experience in turning our closed eyes to the light. Preyer has emphasized the fact that the child, during the first weeks, shows no sign of feeling light (of moderate intensity) differently from darkness except when a *large part* of the field of vision is illuminated or shaded,[23] and Garbini confirms this by several experiments.[24] In this automatic rolling of the head away from a dimmer field toward a less dim, then, we cannot see anything like real looking, any sense of direction, or consciousness of surroundings.[25]

ginning of a fixation that comes about through reflex action" (der Anfang einer auf reflectorischem Wege zu Stande kommenden Fixation). Fixation seems as a matter of fact to develop out of the primitive *eye* movements, rather than out of this neck movement; yet the latter has no doubt a subsidiary part in it.

[23] The Senses and the Will, p. 178.

[24] *Op. cit.*, p. 15.

[25] I recorded in my notes another movement of apparent fixation, still more difficult to explain than the turning toward the light; and as it

No more advanced movements of visual adjustment than these have ever been reported in the newborn. No trace of accommodation to distance has been found before the third week, and even then (as both Genzmer and Preyer were satisfied[26]) in a merely illusory way, without any real adjustment for visual purposes.

II. AUDITORY SENSIBILITY.

Hearing was not apparent at all till the third or fourth day in my niece. On this day, and for several days after, she started, or even cried out, at the sudden sharp sound of rustling or tearing paper. For the whole of the first fortnight, hearing was nothing more than a weak and variable sensibility to auditory shocks (I, p. 107).

As to the *time* at which this sensibility appears, the evidence is highly contradictory. Kussmaul found that he could make the loudest discordant noises in the ears of newborn infants, without disturbing them in the least.[27] Czerney, in his experiments as to the soundness of sleep, was unable to use sound as a stimulus with them, because of their failure to respond to sound-impressions.[28] Sigismund held that "the ear is as good as closed in the first weeks," and that it is not till after three to eight weeks that the child begins to shrink at sudden noises.[29] Champney's child, during the first week, "would not start at any noise, however sudden, when unaccompanied by vibration of the room or bed," and even at 14 days old he gave no unmis-

remains entirely uncorroborated, I have not mentioned it in the text. This was a persistent turning of the head, from the first day, toward an approaching person—that is, toward a large *dark* body, intercepting the light. I can account for this only as another transitory survival of an ancestral reflex movement. The response by motor discharge of some sort to the approach of a dark mass is undoubtedly a very primitive reaction; and though it usually takes the form of shrinking or warding movements, there is also in the higher animals so inveterate a tendency to turn *toward* a dark mass in the indirect field of vision, in order to look, that we might possibly catch a glimpse of it now and then in the form of a true reflex movement, briefly appearing in the newborn, and fading at once before higher forms of control.

[26] Genzmer, *op. cit.*, p. 24; Preyer, The Senses and the Will, p. 50.

[27] *Op. cit.*, p. 38.

[28] The Psychology of Childhood (Tracy), p. 21.

[29] *Op. cit.*, p. 22.

takable sign of hearing.[30] Flechsig found the cochlear fibers of the auditory nerve, at a week after birth, still only beginning to be developed beyond the lower corpora quadrigemina.[31]

On the other hand, Genzmer,[32] in thirty careful tests, and Moldenhauer[33] in fifty, using means to produce an extremely loud, sudden, piercing sound near the ear (without jar or air-current) obtained unmistakable slight reactions on the first day, and even in children only six hours old. Mrs. Hall's careful and trustworthy notes record a distinct reaction to sound (that of an electric bell on the outer wall of the house) at *three* hours old,[34] and a similar instance is given in one of the Talbot papers.[35] Several other observers place the first reaction to sound on the 2d or 3d day, or within the first week.

TABLE III. TIME OF FIRST REACTION TO SOUND.

AGE OF INFANT.	OBSERVER.
Three hours	Hall. Case A, Talbot papers.
Six hours	Moldenhauer. Deneke.[36]
First day	Genzmer.
Second day	Sully. Moore. Case C, Talbot papers.
Third day	Feldbausch.[37]
Third or fourth day	Shinn.[38] Sharp.[39]
Fourth day	Preyer.
Fifth day	Tilley.[40]
First week[41]	Kroner.
First fortnight[41]	Darwin.
After first fortnight	Champneys. Catterall.[42]
Three to eight weeks	Sigismund.

[30] Papers on Infant Development, p. 42.

[31] Ueber die Associationscentren, p. 53; Gehirn und Seele, pp. 53, 106 (Fig. 4).

[32] *Op. cit.*, p. 19.

[33] The Senses and the Will (Preyer), p. 78.

[34] The Child-Study Monthly, II, 8 (Jan., 1897), p. 465.

[35] Case A, p. 12.

[36] Reported by Preyer.

[37] Reported by Genzmer.

[38] I did not myself see the reaction till the 6th day, but it was then very credibly reported to me as having occurred before; and again, as this goes to press, in the case of a nephew, 3d day.

[39] MS. record of Mrs. Eleanor Sharp.

[40] MS. record of Mrs. Laura Sawin Tilley, A.M., Smith College, '92.

[41] This may, however, have been within the first days.

[42] MS. record of Mrs. Helen Tunnicliff Catterall, A.B., Vassar College, '89, and Fellow of Chicago University.

It cannot be doubted, then, that under extreme stimulus many infants will show a certain responsiveness to sound on the first day of life. No child has ever been reported as doing so in the first three hours; and it is well established that the ear immediately after birth is not in a condition to receive sounds.[43]

Aside from the question of the *date* of appearance, all observations agree as to the condition of hearing in the newborn. All have found it weak, and several speak of its curious *variability* not only as between different individuals, but in the same child at different times,—a sound is reacted to strongly at one time, and utterly unheeded at another.[44] Observations agree,[45] too, that to reach the centers and excite motor reaction, the sound must be of the nature of a sharp auditory shock. There is no sign that the ear takes in gentle sound continuously and with comfort as the eye does light, or that the multitude of sounds, loud and soft, going on about the child, are heard at all; only one now and then seems to have the penetrating power necessary to startle the nerve-circuit into action.

Taking into account the insensibility of the infant to all but a few startling noises, the character of the reactions (quivering of the eyelids, convulsive movements of the arms and head, starting, general restlessness, and finally screaming), and the testimony of Flechsig above quoted, that the cochlear nerve-paths are functional only as far as the lower cerebral centers, it seems

[43] "The tympanum at birth is packed with areolar tissue, which only gradually becomes absorbed." Champneys, in the Papers on Infant Development, p. 42.

"The child cannot hear immediately after birth, because a gelatinous substance closes the outer passage, and the middle ear still holds too little air." Ufer, Notes in Kind und Welt, p. 179.

"The outer auditory passage is not yet permeable, the tympanum being set too obliquely." Preyer, The Senses and the Will, p. 182. "There is also to be taken into account as a cause of the deafness of the human being at birth, the temporary closing of the external auditory canal, which is due, according to Urbantschitsch, to absolute contact of the coatings"—p. 75.

[44] I, p. 107; Kroner, *op. cit.*, p. 6; Mrs. Moore, *op. cit.*, p. 63; Tracy, *op. cit.*, p. 24.

[45] For a single exception see a note by Mrs. McLeish, cited on p. 119, footnote.

open to serious question whether the reactions to auditory stimulus in the first days indicate that any true sensation of *sound* has been experienced. Moldenhauer has already raised this question, and conjectured that the feeling experienced may be *pain*, not sound.[46] With our present growing knowledge of the distinction in function between the canals and the cochlea, it is a more probable conjecture that the infant experiences, through the cortical connections of the canals (connections that seem to be functional at this time)[47] a certain auditory *jar*, such as we ourselves experience in harsh, sudden noises, underlying the sound, as it were.

It is impossible to guess, of course, how much consciousness of true sound may be mediated through the lower centers, with which the cochlea is already connected; but it hardly seems possible that this could be just the same sort of consciousness of sound as that which we know by means of the cortical center; nor does the infant's behavior indicate that it is.

Whatever the exact nature of the auditory sensations received at first, the reactions all tend to show that they are very dull, but that whenever they are strong enough to have an emotional effect, it is of a disagreeable type, with an element of shock.[48]

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[46] Kroner, *op. cit.*, p. 7.

[47] Flechsig, Ueber die Associationscentren, p. 53; Gehirn und Seele, pp. 53, 63, 75. The probability that the centripetal paths from the canals end in a region close to the cortical radiation of the skin and body-interior paths, not in that of the cochlear paths, strengthens the theory that the sensations excited through them are rather of jar than true sound.

[48] Genzmer (*op. cit.*, p. 20) mentions one reaction of different character. He found in the case of children who heard best that if he struck the bell softly, close to one ear, the head was sometimes turned toward that side. The observation is entirely unconfirmed; but it suggests a curious analogy with the early turning of the head upon visual stimulus (pp. 26–27); as though the deeply-fixed race habit of turning the head toward a sound also made its appearance now and then in the first days of life as an imperfect and unstable reflex, disappearing quickly before higher forms of muscular control, and reappearing later as a voluntary movement. This reaction occurred only when the sound of the bell, though sudden and penetrating enough to act as a stimulus, still fell short of giving intensive stimulus, and was not actually disagreeable. See, too, the citation from Mrs. McLeish, p. 119.

III. DERMAL SENSIBILITY.

(1) *Contact.*—With regard to the baby's sensibility to contact, I made no observation of any importance except that she seemed to experience a feeling of general comfort in being touched and cuddled (I, p. 136). The well-known reactions of sucking and swallowing at the touch of the nipple on lips and tongue, and of clasping down the fingers at a light pressure in the palm, occurred, as in every nursery.

(2) *Temperature.*—As to temperature sensibility, the baby was kept at as constant a temperature as possible, and gave no sign of being affected in any way by such variations as did occur.

(3) *Pain.*—Of dermal pain sensibility I saw absolutely no sign before the sixth month; this was in the absence of special tests, but there is no doubt that the sensibility was extremely low (I, p. 144).

(1) There is no doubt whatever that infants respond readily to *contact* stimuli, sometimes even from the moment of birth.[50] Besides the familiar reactions mentioned just above, a great number of varied responses to local touches in different parts of the skin were observed by Kussmaul, Genzmer, Preyer, and Kroner, who carried out systematic tests. These tests proved clearly, however (as ordinary observation would lead us to expect), that it is *only about the face,* especially the mouth and eyes, that a fine sensibility exists; over the rest of the body, excepting the palms and soles, the contact sensibility is decidedly dull.

(2) It is also well established that *cold* stimulus calls out lively reactions in the earliest days,—either a moderate cold widely extended over the skin surface, or very cold local touches.[51] Whether warmth is felt as such, or is merely a condition necessary to keep up general organic comfort, I think no one has tested in any way,—as by local heating of the skin.

(3) Dermal sensibility to *pain,* all observers agree, is remarkably low in the first days of life. There has been natural reluc-

[50] Preyer, *op. cit.*, p. 32; Kroner, *op. cit.*, p. 9.

[51] See especially Genzmer's experiments, in which he tested more than 20 children, by touching with an ice-cold iron rod, and also by wetting the skin and blowing on it. *Op. cit.*, p. 9.

tance to experiment on this point, but chances for observation occur in small surgical operations, and Genzmer ventured to test some sixty babies deliberately with needle-pricks. His conclusion was that in premature infants, and for a day or two after birth in normal ones, the skin has practically no sensibility to pain, and for weeks longer the reactions are in his opinion of doubtful character.[52] Kroner, however, says that he has often seen distinct pain reactions—crying and distortion of the face—in newborn infants, on strong electrical or mechanical stimulus of the skin, and Preyer points out that while a stimulus of limited *extent,* like a prick, however sharp, may be ineffective, one that reaches a large number of nerve-ends, as a slap or pinch, always produces reactions from the first day.

In the question how far dermal stimuli are really *felt,* with true sensations of touch, pain, heat and cold, we have a more complex problem than in the case of sight and hearing.

First, as to the evidence from the infant's behavior:—Mrs. Moore and Mrs. Tilley both confirm my observation that from the first day this indicates pleasure in gentle contact.[53] I believe it would prove true in every nursery that the infant shows signs of comfort when patted, stroked, or held against one's face or breast; and this can hardly be due to sensations of warmth, which would reach the child but slowly through his wrappings —nor is the body that touches him likely to be quite as warm as his own. It is only in case of a somewhat *broad* contact impression, with soft pressure, that this feeling of content is shown:[54]

[52] *Op. cit.,* p. 12.

[53] Mrs. Moore's boy "ceased crying a number of times when a hand was laid on his body" (*op. cit.,* p. 73). Mrs. Tilley's child "from the first" seemed to enjoy having his head rubbed and his hair smoothed; "he would shut his eyes and look the picture of content" (MS. record). In the case of my niece also it was this somewhat *extensive* contact, with light pressure —a hand laid on the body, stroking, pressing her body or face against ours—that caused signs of content; not mere touches.

[54] A like contented behavior is always noticed in connection with the sucking response, even where no satisfaction of hunger is concerned; but this, I think, is not caused by pleasure in the touch on the lips that provoked the movement. Perhaps the *continuous pressure* of the object that is sucked is agreeable; but probably still more the sucking movement.

in the tests referred to above, where mere touches with finger-tip, with a warmed glass rod, a feather, or a hair-pencil were used, there is no record that any sign of agreeable or disagreeable feeling was given; and indeed, the peculiarly neutral and indifferent manner of the infant's ordinary touch reactions (as when his hand clasps a finger laid in it) is evident to casual observation. But sensations from light, transitory touches are apt to be neutral in their "affective quality" at all times of life, so that this behavior of the infant is no evidence that the touches are not felt. It is more significant that the acephalous child examined by Preyer, which did not react in the least to light or sound, reacted quite normally to a number of touch stimuli. This is conclusive evidence that in the human infant, as in the lower vertebrates, the primary touch centers *can* act in the entire absence of any connection with the cerebrum; and probably do so act in the normal infant, in the case of many touch impressions,—which could, therefore, be felt only as far as these lowest centers may have a consciousness of their own.[55]

[55] Flechsig says broadly: "In human beings, to destroy the cerebral sense-centers destroys sensation." (Ueber die Associationscentren, p. 56.) But elsewhere he says, "It is *in nowise* proved that only the gray cerebral cortex can mediate consciousness;" "Feelings and elementary sensations may very well be connected with all the lower brain parts. . . . As the cerebellum shows no connections at all, or highly rudimentary ones, with the higher sense-organs, the consciousness mediated by the cerebellum could have for content only the body feelings, and all sorts of touch impressions;" "Anatomy shows plainly that in the lower brain parts apparatus are given that are able to mirror back from within the whole condition of the body;" while in the cerebral tract assigned to the sense of touch "the body for a second time" and on a higher plane, "mirrors itself in its whole extension." (Gehirn und Seele, pp. 12, 19, 21, 38.)

Whether reactions that are solely dependent on the lower parts of the brain are absolutely unconscious in the human being—or whether there exists, through connections with the cerebellum and *formatio reticularis*, the lower type of consciousness that Flechsig supposes, but which he will scarcely call sensation—we cannot tell; and in neither case would it affect our discussion much. For we cannot suppose that such a lower consciousness would contain the typical qualities, the "specific energy" of the sensations associated with cortical activity; and it is these specific energies that the infant learns to discriminate, to associate, to remember, and out of which he constructs the perceptive sense life whose development we are concerned with.

Unlike touch reactions, those which follow *cold* stimulus always indicate a decided "affective quality" in the sensation—in this case a disagreeable one.

The same thing is true of those which follow pain stimulus, with one remarkable exception: Genzmer found that when infants, at two or three days old, first began to respond to needle pricks, it was not with characteristic pain reactions, but with just such as would follow *contact* stimulus. One might suppose this indicated that while the skin was still insensitive to pain, the mere contact of the needle was felt; but the reactions were clearly distinguished from those of contact by their slower physiological time, and by difference in the location of sensitive spots. It would seem, then, that the paths which belong specifically to pain conductions can be permeable, and yet no specific feeling of pain be excited in the subject. The conjecture follows that in this case the excitations reach only the primary centers, and that it is only in the higher centers that pain impressions and contact impressions are differentiated. Yet characteristic pain reactions can not always be regarded as evidence that the higher centers are involved, for the acephalous infant mentioned above, and a similar one examined by Flechsig, both reacted (very feebly) with cries when the skin was slapped or pinched. The facial expression of discomfort and the generally disturbed behavior is safer evidence that pain is really experienced than the mere cry. Even these are, after all, signs of disagreeable feeling in general, not of pain specifically.[85] Still, knowing how much more restricted are the paths of motor expression than those of sensory impression, and how invariable in later life is the rule that excitations of specialized nerve-ends never produce any but the special corresponding sensations, we may reasonably conclude that when a stimulus calculated to excite the nerves of pain is applied, and general signs of discomfort follow, the form of discomfort experienced is really pain.

The evidence of brain anatomy, so far as it is clear, confirms that of the infant's behavior. It is precisely in that region of the cerebral cortex to which sensations from the skin and the

[85] But see below, p. 44, and note 84.

body interior are assigned that Flechsig found medullation beginning earliest (at least two months before birth) and most advanced by time of birth; and he was satisfied, both on anatomical and clinical grounds, that several sensory conductions from the lower centers in medulla oblongata and spinal cord are functional up to the cortex a month before birth. It is impossible, of course, to determine anatomically whether these conductions include separate paths for contact, pain, and temperature excitations. But it may be inferred from the observations related above that they do; that the contact paths are earliest developed and most permeable; and that those of pain are barely functional at birth. This supposition brings the anatomical evidence wholly into accord with the observed facts; for no one has reported any reaction to pain stimulus in infants prematurely born, while contact stimulus is responded to by those born at eight months about as readily as by those born at full time.[57] It accords also with the old argument that touch must be the first special sense to develop, since it is the one that has opportunity of pre-natal exercise.[58] Phylogenetically, too, contact sense is very early in order of development; this is true of the sense of cold and heat also, but not of sense of pain.

Of any "local sign" in skin sensation I saw no indication whatever for many weeks. There was not even the most auto-

[57] Kussmaul, *op. cit.*, p. 33; Genzmer, *op. cit.*, p. 7.

[58] See the summary of early speculations on the senses of the newborn prefixed to Kussmaul's "Untersuchung über das Seelenleben des Neugeborenen Menschen"; also p. 5 of the same treatise. There seems no reason why the argument is not valid as regards contact sensations, though Kussmaul's views regarding prenatal exercise of taste must certainly be set aside (v. Tracy's Psychology of Childhood, p. 1, for a good summary of the whole question of prenatal sense experience).

The medullation of the optic nerve before light has ever reached the retina shows that early medullation is not ontogenetically due either to the exercise of function or to the impact of stimulus, however it may be phylogenetically; but the acceleration of its development in the visual paths of prematurely born infants, under stimulus of light (p. 23, note 18), shows that individual experience of stimulus does play a part in the rate of development of the sheath. We may therefore fairly enough credit the very early development of a functional condition in the paths between the skin surface and the cerebral cortex, in part at least, to exposure to contact stimuli before birth.

matic reflex tendency to turn the eyes or move the hand toward the spot affected.[59] And since at a later period this ability to localize might be seen in process of gradual development, it seems to me out of the question to suppose it existed already, in these earliest days.

The only recorded observation I have seen that suggests its existence at this time is one made by Kussmaul, and confirmed by Genzmer, viz., that hungry infants, only a few hours old, will turn the head at a touch on the cheek, and seize the touching finger with their lips. Genzmer considers this due simply to a diffusion of motor stimulus (from the joint effect of hunger and the finger touch), which sets the head turning; the finger is then accidentally touched and sucked. But if there is really a tendency to turn the head *toward* the touch-stimulus (under the condition of excessive reflex excitability caused by hunger), we may see here an analogy with the turning toward an auditory stimulus, seen by Genzmer (p. 31, n. 48), and the well-known turning toward visual stimulus (p. 26). In such a general tendency to *movement toward stimulus* there can be only a very old reflex activity, not any evidence of conscious localization.

IV. SENSIBILITY TO TASTE.

I made no tests of taste sensibility. But the dulness of the sense, even after the child was half a year old, made me believe that its condition at birth must have been most rudimentary.

The objective facts as to taste reactions in the first days of life, are well settled (with one exception, to which I will recur). The indifference with which children for weeks after birth swallow strong-flavored medicines has been noted over and over.[60] Never-

[59] "There was absolutely no evidence of the ability to locate such a sensation in a part of the body which he recognized. . . . The slow and laborious process was apparent by which the mental separation and differentiation of the bodily parts and surfaces were developed." Mrs. Moore, Mental Development of a Child, p. 77.

[60] Camomile tea (Sigismund), cod-liver oil (Champneys), soda mint (Mrs. Moore), aromatic spirits of ammonia, as I myself saw, were swallowed like so much water. Mrs. Cooley's boy, from the 2d to the 6th week, was treated before and after each feeding with a very bitter drug, for sore mouth: "Whenever he felt the swab at his lips he would cease crying.

theless, the systematic tests of Kussmaul and Genzmer establish the fact that decided reactions to gustatory stimuli can be called out soon after birth, and Preyer and Kroner endorse their results. These were, in brief: Sugar and *weak* quinine or vinegar solutions (usually from one fourth to one per cent.) excite sucking movements and behavior of comfort; stronger quinine and vinegar solutions, characteristic grimaces; still stronger, defensive reactions,—choking, opening the mouth, protruding the tongue, ejecting the fluid, and at last (at a strength of four or five per cent. quinine), restlessness and crying. Any adult finds even a one per cent. solution of quinine strongly bitter;[61] with the infants it often required a two per cent. solution to produce a grimace; in one or two cases, quinine up to a strength of above five per cent. was sucked like sugar.

So far it would seem established that the responsiveness to taste stimulus is extremely slight. But there is one group of data (a somewhat doubtful one, to which I referred above in saying that the objective facts were well settled, with one exception) which seems to contradict this conclusion. It is a general belief that infants very early discriminate well between one milk and another, and reject a strange breast. Sigismund and Kroner mention the belief with acquiescence, but I know of no recorded observation that confirms it except Preyer's.[62] His child, on the fourth day of life, refused cow's milk until it was sweetened, and Preyer believes he must have compared its sweetness with the mother's milk. It is possible that a finer taste sensibility exists as to milk than as to other forms of stimulus. Yet it is hard to think that infants who suck a two per cent. solution of quinine as if it were sugar, can distinguish between

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and suck eagerly at the linen during the process of washing.'' (MS. record.) Tiedemann alone reports apparent repugnance to a medicine within the first five weeks; and he was very likely misled by the facial expression (pp. 39–40). Kroner asserts, however, that the infant will not take these alien fluids *as readily and perseveringly* as milk.

[61] Quinine can be perceived by sensitive adults up to a dilution of one part in nearly a half million parts of water (Lloyd Morgan, Animal Life and Intelligence, p. 251).

[62] The Senses and the Will, p. 124.

a little more or less sweetness in milk.[63] It is still harder to think that at four days old definite associations and the power of comparison and choice are established. We are in need of more numerous and precise reports as to the conditions under which one milk is accepted and another refused, or perhaps I should say, one stimulates sucking and swallowing, and another fails to do so.[64]

That new born infants really experience taste sensations like ours, Kussmaul and Preyer are positive, impressed by the fact that sweet, bitter, and sour call out each the appropriate mimetic expression.[65] Genzmer thinks these mimetic reactions quite unconscious, and it is not till several weeks after birth that he finds evidence of true taste sensations,[66] viz., emotional reactions *without* the local ones (p. 19).

As a matter of fact, the so-called characteristic expressions of taste are far from being exclusively taste reactions. The "sweet" expression is merely the contented look that regularly accompanies the sucking movement, and is excited, together with the movement, not only by any moderate taste stimulus—sweet, sour, or bitter—but also by tactile and olfactory stimulus.[67] The "bitter" expression, with the choking reactions, is excited as well by touches at the root of the tongue, or by strong smells, as by taste stimuli;[67] it appears sometimes at any sudden taste, even of sugar,[68] or water (I, p. 160), and in older children and

[63] Mrs. Cooley's baby (see note 60, page 37), who was fed from the first on artificial foods, showed no preference among them, taking an unsweetened one as readily as one with sugar. My nephew at 10 weeks old, I note, did not seem to notice or care when the sugar chanced to be left out of his milk.

[64] It has been conjectured that the refusal to accept a strange breast was due to the unfamiliar *odor*. Genzmer and Kroner both assert that it is merely a matter of touch conditions, and that no objection is made to taking a strange breast if the nipple is easy to lay hold on, or a nipple cap is used. This explanation, however, does not cover the case of the discrimination reported by Preyer between sweetened and unsweetened cow's milk.

[65] Kussmaul, *op. cit.*, pp. 26–28; Preyer, The Senses and the Will, p. 119.

[66] *Op. cit.*, pp. 14, 15.

[67] Kussmaul, *op. cit.*, pp. 29, 30; Genzmer, *op. cit.*, pp. 5, 6; Garbini, Evoluzione del Senso Olfattivo nella Infanzia (Firenze, 1897), p. 15.

[68] Kussmaul, *op. cit.*, p. 25; Preyer, The Senses and the Will, p. 119; Kroner, *op. cit.*, p. 3; I, p. 160, of this series.

adults it expresses nausea rather than the sensation of bitterness.[69] So far, then, from being well-defined reactions to sweet and bitter taste, these expressions in early infancy seem to be general motor responses, the one to almost any moderate stimulus, tactile, gustatory, or olfactory, in the sensitive regions of mouth and nose, the other to various over-sudden or over-strong stimuli in the same regions.[70]

That these reactions come from the primary taste center, without requiring cerebral participation, is certain, for they have been seen in an infant wholly destitute of cerebrum.[71] Whether there is in normal children at birth any path practicable for the further transmission of taste impressions to the cortex is not known, nor is the cortical center of taste yet certainly located (Flechsig supposes it to be united either with the touch or the smell center[72]), so the anatomical evidence is not available here.

Yet we may, on the whole, conclude that gustatory sensation of some sort exists. The general behavior of contentment that follows on sweet stimulus seems to follow at once, before sucking is fairly established, so that it can hardly be due wholly to pleasure in the motor and tactile sensations. Preyer thinks the behavior of displeasure upon strong bitter tastes unmistakable, and even if it does, as Genzmer thinks, lack the fullest evidence of being a true emotional expression, the probability is, after all, strong that it is such. There may be only a sub-cortical consciousness involved, and the feelings may be quite indefinite ones, of mere gustatory well-being and ill-being; or it may be that some of the impressions do make their way to the cerebral cortex, and are associated with sensations like our own in specific quality.

Taste, at least in the primitive form of a chemical sense able to distinguish proper food material, is of early origin phylogenetically. But throughout the whole mammalian period of human

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[69] Kussmaul, *op. cit.*, pp. 28, 30; Genzmer, *op. cit.*, p. 14.

[70] The difference between the "bitter" and "sour" grimace Genzmer attributes (*op. cit.*, p. 15) to the astringent effect of acid on the gustatory bulbs, which slightly modifies the motor reaction.

[71] Preyer, Die Seele des Kindes (3te Aufl., Leipzig, 1890), p. 93.

[72] Ueber die Associationscentren, p. 53, note 2.

ancestry, discrimination and choice of food has been excluded during the first months of life, and this may have greatly delayed the sense in its ontogenetic development.

V. SENSIBILITY TO SMELL.

I saw absolutely no sign of sensibility to smell, but, rather, indications of its absence for months after birth (I, p. 174).

All observers agree as to the absence of any *spontaneous* signs of sensibility to smell in the first weeks. Yet artificial tests establish its existence from the first hours of life, as soon as the nasal passages are cleared of the amniotic fluid.[73] It has repeatedly been objected[74] that the odorous substances used by the experimenters had a certain irritating effect on the mucous membrane, and also that in applying them the element of touch stimulus was not wholly excluded, so that the reactions may have indicated tactile rather than olfactory sensibility; but after making all allowance for this, there is still plenty of evidence of reaction to olfactory stimulus.[75]

These reactions correspond curiously in type to the taste reactions,—a mild stimulus calling out sucking movements; a

[73] Kussmaul, *op. cit.*, p. 34; Genzmer, *op. cit.*, p. 18; Kroner, *op. cit.*, p. 4; Garbini, Evoluzione del Senso Olfattivo, pp. 15, 16.

[74] Preyer, The Senses and the Will, p. 131; Garbini, *op. cit.*, pp. 5–7.

[75] Genzmer applied odorous liquids to the upper lip, a method that, no doubt, gave opportunity for stimulus from contact or wetness; but the reactions were not like those that follow contact or wetness, and were like those obtained by Kroner and Garbini, when they put the odorous substance on the nurse's breast.

So, too, as to the criticism that the reactions may proceed from irritation of the membrane by the vapors of strong volatile substances: when such substances as petroleum, amber oil, or asafœtida are used, the reactions are wholly unlike those which follow tactile irritation of the membrane. Garbini, who refuses to regard responses to any of these odors as truly olfactory, and names them "osmo-tactile," lays stress on his failure to obtain response when he used a different class of odors, such as that of decaying flesh. But in the absence of any power of active smelling it can not be expected that the infant will respond to any but strong, penetrating odors from volatile substances, which will pass spontaneously up the nostrils. Moreover, long after smell is unquestionably established, little children (in the second and third year) often fail to show the least repugnance to odors that seem to us offensive.

stronger one, grimaces; and the strongest, choking, opening the mouth and putting out the tongue, and at last, restlessness and crying. But signs of an affective element in the feeling experienced are plainer than in the case of taste reactions; so, at least, Kroner's report indicates decidedly.

Anatomically, we have plain evidence that smell impressions can reach a center of higher consciousness, since the olfactory paths are medullated to the cortex some weeks before birth.[76] It is perplexing that this sense, to all appearance the latest and the least developed of all in humankind, should be so early in functional condition, but there seems no doubt of the fact.

VI. SENSIBILITY TO MOTION, POSITION, AND MUSCULAR ACTIVITY.

This group of senses—"kinæsthetic and static"—has never been subjected to tests of any sort during the period of infancy. That the movements and positions of the body are felt from the first has been rather assumed than argued; but the assumption is altogether probable, since, unless these are felt, the formation of associations with them and the development of voluntary movement out of involuntary—processes that begin very early—would be impossible. There are sundry detached observations that support this belief. It is known in every nursery that babies are sensitive to jarring, and Champneys has recorded that immediately after birth his boy started when the scale of the balance in which he lay went down with a jerk.[77] Two babies, twins, reported in the same collection of papers, showed from the second day a remarkably sensitive feeling about changes of motion and equilibrium,[78] starting, gasping, and clutching with their hands as they were turned over, raised or lowered in bathing.[79] My niece seemed from the first to suffer discomfort if she lay long in one position,—a feeling made up of sensations of muscular and joint tension, pressure on the skin from the

[76] Flechsig, Gehirn und Seele, p. 53; Ueber die Associationscentren, p. 53.

[77] Papers on Infant Development, p. 42.

[78] Papers on Infant Development, p. 17.

[79] So also Mrs. Hall's child, and Mrs. Meade's (reported in a letter), for the first two months of life.

weight of the body, and organic ill-being due to impeded circulation. Experienced mothers and nurses make it a rule to change the position of little babies from time to time, and its effect in quieting restlessness is noticeable.

Anatomically, we have every reason to suppose that sensations of this class are experienced, even before birth, since in the eight-months fœtus the posterior plate of the spinal cord and the mucous membrane of the ear-canals are not only fully connected with the cerebellum, but have medullated continuations to the cerebral cortex.[80] It may be conjectured, however, that the limited number of paths which are permeable to the cortex at this time, or even at the time of birth, does not include representatives from *all* the spinal nerves of sense. The movements of the infant in the first weeks tend to come under control progressively, from the head downward (I, p. 181); and as it is the rule of development that each motor nerve bundle begins to sheathe itself downward as soon as the corresponding sensory bundle has sheathed itself upward,[81] we must suppose that the sensory consciousness of the body-parts had already arisen in the same order. It is, therefore, possible that in the newborn infant it has progressed only so far that he feels the movements of his eyes, lips, tongue, and neck, but not of trunk and limbs.

VII. ORGANIC SENSIBILITY.

It has not needed systematic tests to show that the newborn infant reacts to hunger, thirst, and organic pain, with every appearance of distress.

The part that *hunger* plays has doubtless been exaggerated by casual observation, and that of *thirst* underrated. It is some 48 hours after birth before the organic need of food sets in (I, p. 211; see also any modern text-book of nursing): yet during this time restlessness and crying appear periodically, and are appeased by water alone. Even after this, the craving for food must be quite as much thirst as hunger, and thirst alone is apparent at intervals besides (I, p. 234).

[80] Flechsig, Gehirn und Seele, p. 62, *et seq.*

[81] Flechsig, *op. cit.*, p. 20.

Nor can the thirst-hunger craving be as strong as it seems, at any time in the first week; for its signs wholly cease if the infant can get anything convenient into its mouth and suck at it,—the pleasure of sucking apparently quite obliterating the organic discomfort. Genzmer, indeed, doubts whether there really is any sensation of discomfort, or whether the motor discharges are not due simply to the heightened reflex excitability that attends the physiological condition of hunger;[82] when this excitability is discharged instead by the movement of sucking, the other reflexes (throwing the head and arms about, and crying) cease. But the whole expression and manner of the hungry child indicate discomfort; and we need not doubt that thirst and hunger are really felt, since it is known that by the time of birth there have been for weeks practicable paths for visceral impressions up to the cerebral cortex.[83] This accords, too, with the early appearance phylogenetically of some sort of hunger craving; and with the early appearance in the individual of associations in connection with hunger (I, p. 213).

Organic *pain,* unlike dermal, seems to be distinctly felt very early. Within a few days after birth, certainly, experienced nurses distinguish well between the cry of colic, that of hunger, and that of fatigue.[84]

Of other organic sensations in the newborn, it may be said briefly that *nausea* seems entirely absent at this period, and for

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[82] *Op. cit.,* p. 18. In this reflex excitability, especially to touches about the lips or any stimulus adapted to call forth the sucking reflex (Genzmer, *op. cit.,* p. 17; cf. also Kussmaul, *op. cit.,* p. 30; Preyer, The Senses and the Will, pp. 152–153; Champneys, Papers on Infant Development, p. 41), there is a marked trace of remote phylogenetic origin.

[83] Flechsig traces the vagus and its continuations to its cortical radiation, in the 8-months fœtus (Gehirn und Seele, p. 63).

[84] I, pp. 208, 211. Preyer thinks the cries distinguishable from the first (The Senses and the Will, pp. 152–153); Darwin could not distinguish them for weeks, though he was watching especially for emotional expression (Papers on Infant Development, p. 39). Champneys says that the child appeared to cry at first for three reasons, (1) loneliness or fright; (2) hunger; (3) pain; and that the cries seemed to be all different in character. But this distinction was probably not made in the very first days. Papers on Infant Development, p. 41.

months after.[85] Feeling of *suffocation,* it has been conjectured,[86] may be experienced on the interruption of the placental circulation, and may cause the first cry. Genzmer found that stopping the nostrils would bring infants to crying in about ten seconds.

VIII. GENERAL SENSATION.

One can hardly doubt, in watching a newborn baby, that he experiences vague shades of comfortable or uncomfortable feeling, which can be referred to no definite stimulus. Yet on the whole, the behavior of a healthy child, in these first days, is extremely passive and neutral in the intervals between definite sense experiences. There must be a multitude of faint impressions continually pouring inward from visceral and circulatory conditions, from muscle and joint tensions, from the contact of clothes with the skin, the pressure of the body on the bed, etc.; but whether the majority of these reach the threshold of consciousness at all is doubtful, the cerebral paths being so few, and most of them still so resistant. Whatever undifferentiated net result of feeling is experienced in consequence of them must be of the very faintest, and does not seem to be continuous. If there is any real continuum of feeling, underlying and connecting special experiences, it is probably sub-cortical.

Yet there is no room for the conjecture that the infant lies in an unconscious condition, broken from time to time by special experiences; for the special experiences practically fill all his waking hours. In particular, the lively sensibility of lips and tongue is stimulated by their perpetual touches upon one another; while their movements and those of the eyes are felt; and light is constantly reaching the retina, unless the room be wholly darkened. The larger part of the content of the baby's consciousness, then, in the first days, comes from sight, muscle, and touch experiences, and centers about mouth and eyes.

[85] I, p. 235. Cf. also Preyer, The Senses and the Will, p. 158. The same absence of nausea when food regurgitates is noticed in Mrs. Catterall's MS.; and is, indeed, a familiar observation in every nursery. It has anatomical reasons, in the position of the stomach, which allows the liquid contents to escape without muscular effort.

[86] Kussmaul, *op. cit.,* p. 44; Genzmer, *op. cit.,* p. 16.

IX. SUMMARY AND CONCLUSIONS.

It appears, then, that in normal infants at birth (or as soon as the conditions of extra-uterine life are established) the condition of the senses is as follows:—

1. *Sight* is only a dim[88] and wholly passive feeling of light and dark, without sense of distance or direction.

2. *Hearing* appears with more or less delay, and then only as a dull sensibility to auditory jar, rather than to sound.

3. *Dermal* feeling includes a sensibility to *contact,* lively about the face (especially lips and eyes), and duller over the rest of the body; a lively sensibility to decidedly *cold* touches, though scarcely to diffused cold; and an exceedingly dull sense of *pain,* roused with difficulty by intensive stimuli.

4. *Taste* and *smell* sensations seem wholly wanting under normal conditions, but can be excited by intensive artificial stimulus; it is doubtful whether the taste sensations even then pass much beyond a feeling of gustatory well and ill being. There are indications of imperfect central differentiation of taste from smell and touch.[89]

5. Sensations of *motion,* of *muscular activity and fatigue,* of *equilibrium,* and visceral sensations, chiefly *hunger and thirst,* and *organic pain,* are felt quite distinctly, and make up altogether a considerable mass of feeling from the body interior; yet they are individually feeble at this period, and do not blend into any definite consciousness of the body. There may be some faint undercurrent of *general sensation,* in the intervals of special experience.

6. The content of consciousness in the newborn is chiefly made up of the sensation of light, and of touch and muscular sensations about the mouth and eyes.

[88] Retinal sensibility is keen, and the central paths well advanced in development, but the quantity of light admitted is so small that the sensation experienced must be faint.

[89] This is true even in adult life, to a less extent. It has often been noticed that we distinguish with difficulty between sensations of pure taste and those of smell (received through the rear nasal passages), as in the case of spices; and Groos points out that such sensations as the sparkling quality in wines, or the smoothness of creams, are in fact touch sensations (Die Spiele der Menschen, Jena, 1899, p. 14).

It will be observed that the sensations of the newborn are very limited and feeble, and seem to be simple and detached experiences; there is no sign of association between them, or modification of one by another. And this is confirmed in a striking manner by brain anatomy, which shows that the paths to the cortical centers are at this time very few, and some of them barely matured and probably difficult to traverse; while medullated association fibers are wholly wanting.[90]

Again, there is nothing in the infant's behavior in the first days of life that indicates any memory or recognition of a sensation.[91] Whatever trace may be left behind, at this period, by each single experience, it falls below the threshold of consciousness, and there must be a considerable accumulation of the traces, before they can introduce any representative element into sense experience.

These early experiences, then, unassociated with each other, unassociated with representations of their own former occurrence, are justly to be regarded as *pure sensations,* the simplest forms of consciousness we can conceive. In such experiences as these, there can be no consciousness of space, of externality or internality, of surrounding objects, or of self. Yet since each one has its *specific quality,* these accumulating experiences, once associated, discriminated, remembered, and compared, afford the material for highly-developed psychic life.

One more comment. There is nothing here that parallels any

[90] "Noch einen Monat nach der Geburt sind die geistigen Centren unreif, gänzlich bar des Nervenmarkes, während die Sinnescentren schon vorher—*ein jedes für sich, völlig unabhängig von den anderen*—herangereift sind."—Flechsig, Gehirn und Seele, p. 23. Elsewhere, however, the same authority adds, "Nur zwischen Reich- und Körperfühlsphäre verlaufen einzelne spärliche Bündel welche hinreichend entwickelt erscheinen um eine Erregung von der einen auf die andere Sphäre zu übertragen."—Ueber die Associationscentren, p. 57. We have here again the anomaly, noted on p. 42, of the remarkably early development anatomically of the olfactory center, while to observation smell seems the most belated of all senses, and the one least involved in associations during infancy. With this exception, Flechsig's report of the state of medullation in the cerebrum at birth corresponds remarkably to the results of observation on the state of sensibility.

[91] If we except the incident related by Preyer, p. 38.

phylogenetic stage of sense development. Traces of the phylogenetic order are plain in the delayed appearance of cochlear hearing, the low development of dermal pain, the imperfect differentiation of taste from smell and touch; but they are traces only. Each sense of the newborn child has taken on its human type, in structure and function; the peripheral organs are complete, or nearly so, the centripetal paths are marked out, the centers differentiated; the efficient action of the sense apparatus as a whole is simply suspended, *for lack of central interconnections.* In the phylogenetic series, the effective co-operations of the sense apparatus, called constantly into function for the preservation of the organism, had to keep pace with the development of structure, and low-level interconnections were formed. In the human ontogenetic series the apparatus, protected by long intra-uterine life from any demand upon function while its structure is developing, has leisure to make ready a higher, cerebral type of co-operations, abandoning the lower (wholly or in great part) to the use of organic life. But these higher associative connections do not actually mature till extra-uterine life has begun, and the sense centers are individually in active function.[92] Therefore there is a certain helplessness, and appearance of low sense development, in the young infant, which roughly counterfeits that of the low types of animal life; but without any real analogy. The mistake of those who try to find an analogy (v. Garbini, *op. cit.*) is that they fail to consider the high development of structure, the advanced differentiations, which have already taken place in intra-uterine life, while the parallel development of function was suspended. I need hardly add that it is out of the higher type of sense co-operations thus made possible that man's superior type of intellectual processes is developed.

[92] The physiological process we may conjecture to be that the tension from repeated discharges in the sense centers leads to the medullation of the association paths going out from them, as well as to that of the voluntary motor paths (p. 36, note 58).

PART II. THE SYNTHESIS OF SENSE-EXPERIENCE.

We start out, then, with a content of consciousness made up of a limited number of pure sensations, unrelated, unrecognized, unlocated, but varying distinctly in intensity, in affective quality, and in specific quality, constituting nothing like a unified "stream of consciousness," yet practically incessant during waking hours, since stimulus of one sort or another is never lacking, —from the first a considerable mass of psychic material, awaiting only organization.[1]

The process of organization I attempt to trace in the following chapters. It was in general the establishment of firm associations between sensations that regularly occurred together. Where movement was necessary to bring them together, an indispensable part of the process was the attainment of ability to repeat voluntarily the movement, at first automatic. Also indispensable was the development, at each step, of recognition of former experience.

The great lines of grouping and fusion, as they appear in my record, were as follows:—

1. A series of associations was formed between the visual and the muscular sensations that occurred together in the automatic movements of the eyes; and by means of these associations the power of voluntarily directing the eyes was attained, followed by the power of accommodation to distance, and then by the ability to trace outlines with the eyes,—to delimit surfaces,—that is, to perceive plane form; and, finally, by some purely visual-motor interpretations, viz., rudimentary perceptions of distance, direction, and of objects as such.

2. A like series of associations was formed, during the same period, between the tactile and the muscular sensations that occurred together in the automatic graspings and explorations of mouth and hand; and by means of these associations the power of

[1] For a more detailed attempt to realize the dim and fragmentary psychic life of the newborn, cf. The Biography of a Baby, pp. 55–57.

voluntarily laying hold upon objects and feeling them over was attained,—the power, that is, of grasping and of active touch, with, probably, some rudimentary tactile-motor impressions of distance and direction.

3. By a highly advanced process of re-combining associations, the whole visual-motor group of sensations experienced by the baby in seeing objects grasped by herself, was linked with the tactile-motor group of sensations experienced in the act of grasping; visually guided grasping, and then constant exploration of objects by sight, touch, and muscular sense together, became a habit; and by this means largely (aided by locomotion) the perception of solid form, the complete projection of objects in space, with the space-feeling itself, were slowly acquired.

4. Meanwhile, auditory sensations also became associated with the visual and muscular sensations experienced in connection with them, the source of sounds was sought by the eyes, and some auditory contribution was made to the perception of objects and of space. Another association series, between sounds as heard and the sensations of the vocal organs in producing them, brought about the ability to reproduce them at will, and thus made possible the later acquisition of speech.

The detailed account of the incidents which indicated the foregoing processes has already been published.[2] The following chapters offer a recapitulation and analysis of the most significant points.[3]

[2] Notes on the Development of a Child, under the several sense categories, and that of Grasping, Vol. I of this series.

[3] I compare my results throughout with the records of others, viz.:—

Tiedemann, Soldan's translation of Perez's version, Bardeen's Schoolroom Classics, XIII, Syracuse, 1890.

Sigismund, Kind und Welt, Ufer's edition, Braunschweig, 1897.

Darwin, Champneys, and others, in Mrs. Talbot's collection of Papers on Infant Development, published by the American Social Science Association, 1882.

Preyer, The Senses and the Will, Appleton, New York, 1892.

Sully, The Diary of a Father, in Studies of Childhood, Appleton, New York, 1896.

Mrs. Hall, First Five Hundred Days of a Child's Life, The Child-Study Monthly, Vol. II (1896–1897).

Mrs. Moore, Mental Development of a Child, Macmillan, New York, 1896.

I. THE VISUAL-MOTOR ASSOCIATION SERIES.

1. STARING.

Arrest of the Gaze by High Light.—The earliest sign I saw of emergence from the "newborn" condition of sensibility above described was a fixed staring at light surfaces of moderate extent, such as a lighted tract of the ceiling, the nurse's glasses, etc. This appeared near the end of the first fortnight, and was conspicuous till the fifth week (I, p. 10).[3a]

No other observer has recorded this long, fixed staring as a regular stage in development, though I find incidental mention of it in a number of records.[4] Preyer, in setting down "staring" as the first stage in the acquirement of fixation,[5] seems to refer only to the passive, wandering gaze of the newborn. The staring that I recorded was certainly an advance upon this; the eyes, it is true, were not yet directed at all, but when they encountered by chance an agreeable, mildly lighted surface, they had become able to hold to it. They were under some higher grade of control than before.

The nature of this control is suggested by Sully, when he says that the eyes may maintain their attitude "under stimulus of

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Mrs. McLeish, Transactions of the Illinois Society for Child-Study, III, 2, University of Chicago, 1898.

MS. records of Mrs. Sharpe, Mrs. Beatty, Mrs. Chapman, Mrs. Wood, Mrs. Tilley, Mrs. Catterall, already cited in Vol. I; and of Mrs. Elsie Jones Cooley, A.B., Michigan University; Mrs. Alice Carter Cook, M.S., Cornell, Ph.D., Syracuse; Mrs. Florence Smith Hoyt, A.B., Smith College; Mrs. Martha Everett St. John, A.B., Smith College; Mrs. Laetitia Moon Conard, Mrs. Jessie Saunders, and Mrs. Daniels.

When I cite the above observers without mentioning any title of a volume, it is to the records above enumerated that I shall refer.

As these pages go through the press, I add such notes as can be hastily utilized from my own record of a nephew, now nine months old.

[3a] My nephew at 3 weeks old would stop fretting instantly and his eyes would become fixed, upon encountering lighter tracts, or strong chiaroscuro.

[4] *Op. cit.*, Preyer, p. 3; Darwin, p. 33; Champneys, p. 42; Alcott, p. 8; Sully, p. 401; Mrs. Hall, p. 458; Mrs. Tilley, Mrs. Cooley, Mrs. Conant, MSS. The staring is rarely distinguished clearly either from the passive reception of light that precedes it, or from the attentive looking that follows.

[5] *Op. cit.*, pp. 41, 179.

the pleasure." The eye falls by chance on the lighted surface; the stronger and more pleasant sensation received increases the central metabolism; an intensified discharge passes down the motor paths at the moment in use, their permeability is increased, the wandering impulses drawn into them, and the eye is held to its place, sometimes for many minutes.[6] And, in fact, I have recorded that with the beginning of this staring, the irregular spontaneous movements of head and eyes did decrease and gradually disappear.

Here is, as yet, no sign of any association formed, but rather of a physiological preparation for the forming of one. For with the inhibition of wandering impulses and the deepening of the motor channels by which the eyes are fixed, it must occur that sensations of clear vision and the corresponding sensations in the eye muscles are over and over, and for long periods, set up side by side in consciousness; at the same time, the paths are becoming very easy for the later conduction of voluntary impulses, to bring together the same double set of sensations by intentional looking.

It is evident, too, that some differentiation of the fovea has already begun (since it is on reaching the center of the retina that the bright image fixes the attention), and its further development is favored by the long staring. As to the significance of the stage in the general history of motor development, of will, and of attention, these aspects lie outside the scope of the present treatise, and can merely be mentioned here.[6a]

Neck Movements in Aid of Seeing.—Close on this visual ad-

[6] For an extended discussion of this highly primitive "hedonic" motor control, and the bearing of the "Spencer-Bain" theory on the case of the young infant, see Baldwin, Mental Development in the Child and in the Race, Chap. VII.

[6a] Since writing the above, I find a full recognition of this stage, "staring," and of its significance in the development of attention, in a paper upon Curiosity and Interest, by G. Stanley Hall and Theodate L. Smith, Pedagogical Seminary, September, 1903. Drs. Hall and Smith, in answer to a questionnaire, received reports of 163 cases of infant staring, nearly one-half of which occurred under the age of three months; it is not reported, however, how many occurred under the age of one month —the period where we must look for it if we are to establish it as the first stage in the development of vision.

vance, in the third week, came signs of increased pleasure in organic and general sensation (I, p. 238). It is likely that tactile and muscular sensations were also involved in the pleasure. There seemed a development in pleasure-pain susceptibility all along the line. It was at this period, too, and at moments of highest comfort and exhilaration, and of visibly increased general innervation (I, p. 235) that movements of lifting the head began. Such a movement has been seen as early as the first day,[1] and can not possibly be attributed to desire or volition, but only to an overflow of energy, seeking motor paths easy by inheritance. But it evidently associates itself not long after this period with the pleasure of better seeing, and passes (perhaps by way of a mechanical repetition of the movement, under stimulus of pleasure; see below, "Recurrence of Gaze") into voluntary effort. Even in its involuntary stages, it is important in inhibiting the irregular neck movements, and in preparing for the co-operation of neck and eyes in voluntary looking.

Preyer, however, saw a neck movement at this period (as early, indeed, as the second week), which aided seeing more directly, and which he sets down as "the second stage of fixation." The face was turned from one bright surface to another, within the field of vision, the look remaining a mere stare. Mrs. Tilley records the same thing, and Preyer cites an instance reported to him by Frau Strumpell,—both in the second week. I find no other record of it, nor did I see the movement. I hardly think we are justified in regarding it as a regular stage in the attainment of active seeing. It seems rather to be a development of the original reflex which rolls the face toward the lighted portion of the room (pp. 26–27); it differs from this only in being discharged by a less extensive stimulus. Preyer himself does not regard it as an intelligent or voluntary movement.

Recurrence of Gaze to Accustomed Spots.—My own record shows that there was, as early as the third week, a marked *recurrence of the gaze* to certain favorite spots, such as were to be seen habitually in the same direction, as the baby lay in a

[1] Talbot papers, p. 20; MS. record of Mrs. Wood.

customary position (I, p. 10),—the mother's white forehead, *e. g.*[8] Now this "recurrence" of the gaze may not be real,—the object, favorably located, may catch the eye by chance encounter each time; but I suspect close watching would show that the baby's gaze does not, in fact, roam about till by mere chance it strikes and adheres to its favorite brass knob, or gleaming spectacles, but rather reverts pretty directly to these familiar sources of pleasure.

If so, we have here an advance on the simple *maintenance* of the eye-position in staring; we have a *repetition* of the motor discharge, suggested, after a lapse of time, by the similar conditions, and probably, also, by a craving of the sensory cells for light stimulus.[9] There is no memory, desire, or will in this, but rather the raw material of memory, desire, and will. As I conjecture the physiology of it, the spontaneous tension of growth in the motor cells connected with the eye-muscles, is reinforced by the tension of stored energy in the sensory cells, craving discharge by light-stimulus; and the previous experience of pleasure following a certain eye-movement has so far deepened the channels for that movement that the discharge is determined to these, and the movement is repeated.

For such a process as this, no associative connection is necessary between the centers of visual and of muscular sensation; a connection that, according to Flechsig's dissections, would be anatomically impossible as yet, since the association fibers are still wholly immature. It was only with the beginning of the fourth week, about the 22d day, that I began to detect evidence of any real association established in the baby's mind, and this was not in the visual field at all. She showed signs of recognizing the position in which she was placed for nursing. Even here there is no demand upon the activity of intercentral association paths; for all the sensations involved in the associated group,—organic, muscular, and tactile,—are mediated in

[8] Mrs. Cooley records in the 5th week that a brass knob on the bedpost thus attracted her baby's gaze, but she does not say how early the habit began.

[9] See p. 58 and note 15.

a single region of the cortex, Flechsig's Körperfühlsphäre.[10] The association is therefore of primitive type; nor can I find in any record a single instance of any more advanced type at this stage, with the one exception of the incident of the 4th day given by Preyer, already commented on as doubtful (p. 38).

2. ACTIVE LOOKING.

Turning the Eyes to the Marginal Image.—At 24 days old, close after the first sign of association-forming, my niece turned her eyes, well co-ordinated, and even threw back her head, with looks of attention and interest, to bring objects from the margin of the visual field to the center (I, p. 14).

This advance passes beyond Preyer's "second stage of fixation," in which the face is turned from one bright surface in the field of vision to another, the eyes continuing merely to stare; it has some of the characteristics of his "third stage" (that of following a moving object with the eyes), to which it corresponds exactly in date. It was with the "third stage" that intelligent looking began in his observations.

This intelligent looking marks a great advance. It shows the fovea well established as the region of superior vision, and the "visual local sign" of the outer retinal regions already distinct enough to serve as a guide for the direction and distance through which the ball must be moved to bring the fovea to the desired spot. It also shows a fair co-operation in binocular movement. And evidently we have here under our eyes the process analytically inferred by Wundt: the series of visual sensations experienced as the image falls on the marginal portion of the retina, and thence travels across it to the center, has become so associated with the parallel series of motor sensations that at sight of the marginal image, the motor discharges necessary to produce these sensations take place. The difficult question is whether this association has been brought about by practice,—the first-fruit of individual education,—or whether

[10] On the difficulty of forming dissimilar, as compared with similar, associations, see Wundt, Human and Animal Psychology, Lecture IX.

the movement (though voluntarily initiated) is adjusted to distance and direction by an inherited reflex mechanism.

One is disposed to the latter view, seeing how early and how suddenly the little baby is able to turn his eyes to the right spot. How could he possibly, in three weeks' experience (multitudinous though the roamings of his eyes have been) associate each point in the marginal field with its due visual local sign, and with the appropriate movement of the eyeball? On the other hand, it is difficult to suppose so much and so varied adaptability to differing conditions in an inherited human reflex; the adjustments are more like those of acquired automatic action, as in piano playing, than like those of our undoubted native reflexes.

In fact, the first human movements of looking are probably less skilful than we suppose. Wundt says that the infant *gropes* with his eyes for the object, and fixates it but imperfectly at first. I know of no observer who has recorded this groping, but all our records are wanting in precision at just this important point, and it is quite likely closer observation would prove him right.[10a] Again, the only "objects" to which the eyes are turned at this stage are light tracts, usually several inches in extent, or else something swinging and moving about,—targets that it does not require nice aiming to hit well enough for practical purposes. And in the third place, it is by no means to be concluded that the baby's fovea has learned the road to every point in the marginal field of vision as soon as it has been seen to reach one, or several, with fair success. It is probable that for many days thereafter the instances of *new* achievements in directing the eyes are rare.

My own notes certainly indicate this strongly. For two or three weeks after the first instance of true looking, they continue to mention the long, fixed stare as the main visual activity (only more intelligent and interested in expression than before, sometimes even accompanied with signs of lively delight); they record over and over the recurrence of the gaze to favorite

[10a] I could not detect "groping" in my nephew's case; but his early fixation was certainly very imperfect.

spots;[11] and for the rest, a constant *roaming about* of the eyes, in which disappearing traces of the primitive irregular movements were imperceptibly replaced by a sort of systematic *ranging* to and fro, which looked like a voluntary seeking for visual enjoyment (I, p. 14).[11]

There does not seem too much difficulty, then, in interpreting the development of active looking as a gradual acquirement, learned by individual practice; instinctive only as all these race movements are,—that is, acquired by the individual along lines compelled by his inherited structure.[12] The process of learning, we may conclude, is but *begun* at the time the first successful looking is noted; and closer observations should trace for us its progress thereafter up to completeness, through a series of practice movements, guided by simple associations, and impelled by hedonic feeling.

That such simple associations were forming in several directions[13] was now, at a month old, evident. This agrees well with Flechsig's report of the anatomical conditions at this date.[14]

[11] I have already cited Mrs. Cooley's record of this recurring gaze in the 5th week; and Mrs. Tilley and Mrs. Catterall both mention the ranging to and fro of the eyes at about the same date.

[12] Even in the case of such animals as inherit the most highly developed mechanisms of reaction to sense impressions, it seems to be the tendency of later observers to credit instinct with less perfection, and practice with more influence, than had formerly been done; compare Lloyd Morgan's and Dr. Mills's observations on chickens with Spalding's.

[13] Chiefly the more intelligent and voluntary lifting of the head (I, p. 325).

[14] Ueber die Associationscentren, Proceedings International Congress of Psychology, 1896, p. 59; Gehirn und Seele, p. 74. Elsewhere Flechsig says that at a month old he found *no* medullated association-fibers (Gehirn und Seele, pp. 23–24); but taking this in connection with the more detailed statement on p. 74, it is evident that he must mean "practically none." The first intelligent looking is reported by observers, as a rule, in the 4th week (Table VIII(*b*), p. 77), but there is no great discrepancy here, when one considers that the range of individual variation should easily cover a week; that I did not find the looking really established as a habit before the 2d month; and that the brains used by Flechsig, those of children dying at a month old, would be likely to show some retardation in developments belonging to the latter days of the first month.

Preyer, writing before Flechsig's investigation, and believing the cerebrum to be wholly undeveloped at the time following movements first take place, is constrained to say (in spite of the look of intelligence which he noticed) that no part is played in the progress by the cerebral cortex. From the great difficulty of this position we are now released.

And at just this period, when the infant is mastering the voluntary use of the eye, the formation of associations is in several ways especially favored:—

1. There seems to be from the first in the developing sense-cells not merely the capacity of receiving stimulus, but an actual craving for it,[15] a tension and discomfort in its absence, which stimulates motor reaction. There is thus a movement, a ranging to and fro of the eye, which is steadily directed by the pleasure-feeling, at first automatically, and then by an easy development becomes voluntary movement, determined by associations with pleasant experience.

2. It may well be conjectured that the medullation of the cortex, which at this period is beginning to progress rapidly, takes place in group after group of cells and neurons in an order determined not solely by heredity, but also by pleasure-pain experience, and thus doubly tends to select and fix useful associations. That is: The interconnections necessary for the important race movements would in any case mature rapidly; but, moreover, adjacent groups of sensory cells in which at the same moment a pleasurable excitement is taking place, will exert a tension of excess energy on the undeveloped inter-connecting channels, and thereby hasten their medullation,[16] while others will lag behind. The movement of the eye that fails to bring a bright image to the center of the retina excites no marked interest or attention; but the successful movement, by the cerebral excitement it produces, tends to bring promptly into a functionally matured and co-operating group all the cells and connecting paths involved in the experience. The useful association, in the process of forming, is thus isolated and, so to speak, anatomically protected from competition, and becomes early and invincibly fixed.

[15] See p. 54 above. All my observation confirms Groos's views: "So besitzt, wie Jodl, in Uebereinstimmung mit Beaunis u. A., hervorhebt, jedes Sinnesgebiet nicht nur die passive Fähigkeit zur Aufnahme und Verarbeitung gewisser Reize, sondern es stellt sich auch zugleich schon ursprünglich als das Verlangen nach Erfüllung mit entsprechenden Reizen dar." Die Spiele der Menschen, p. 5. Many movements of the infant seem to be due to this craving.

[16] See p. 48 and note.

3. In particular, the association between clear seeing and the movements necessary to fix the eyes is favored by the physical form of the eye, since the number of cases in which a chance movement will carry the image across the center must greatly exceed those in which it passes over any other one spot; and by the early staring, which arrests the image when it does reach the center, and emphasizes each successful movement by a long rest of the eye in the same position.

It is not strange, then, that a system of association between visual and muscular sensations, sufficient to direct the eye fairly well in right and left movements of fixation, should be organized so quickly as to seem to cursory observation a sudden unfolding of perfect inherited faculty.[17]

Following an Object in Motion.—On the 33d day I first saw the baby's eyes unmistakably follow a candle, slowly moved,—Preyer's "third stage of fixation." Had I tried the experiment before with a luminous object, instead of with the hand, I might, like Preyer, have seen this development earlier than active looking, instead of ten days later. It is really only one case of the same attainment,—that of the ability to turn the fovea upon an image already seen indirectly. The image moves off the fovea by a minute interval, and is at once overtaken by the turning of the eyeball; moves again and is again overtaken; and so on. Mrs. Cooley's MS. record says that her boy, in early following, moved his eyes " jerkily."

It is likely that there are more incipient stages in the ability to follow than we have knowledge of. In the case of my niece, every one else in the house pronounced her eye-movements "following" before I could record an unmistakable instance; and what I regarded as accidental coincidences between the movements of the object and of her eyes may really have been broken and imperfect attempts at following.[17a] For some days before,

[17] The first sign of color vision occurred simultaneously with the first active looking; but the whole subject of Color will be discussed by itself later.

[17a] My nephew acquired the movement by slow stages, 24th–36th days; the successive slight overtakings were quite evident at first. He did not turn the eyes to the marginal image till the 39th day.

moreover,—from about the beginning of the fifth week,—she had had a habit which bore a curious appearance of deliberate practice for the very power under discussion: she would fix her eyes on her mother's face, and roll her head sideways, keeping the eyes fixed, thus holding the image on the fovea by turning the eyeball, quite as much as if it had been the image and not her head that moved. Mrs. Cooley relates a somewhat similar action at about the same date (fifth week): the baby was staring at a photograph which hung near his bassinet; the bassinet was moved slightly, but his eyes remained on the picture. Mrs. Tilley mentions such movements as habitual at five weeks; I saw a decided instance in my nephew in the sixth week.

Genzmer's experiments (p. 25) show that some ability to follow a moving object may be inherent in the reflex mechanism at birth. Such extremely early instances as those reported by Mrs. Moore[18] must be classed with Genzmer's; and the lack of focus, which she expressly mentions, emphasizes the absence of any real fixation. It would seem that there is in the first week a reflex following, which fades out, and is replaced toward the end of the first month by a more perfect movement, of true sensori-motor type. Instances of the movement from the 5th to the 10th days, however, recorded by Mrs. Cooley and Mrs. Moore, are hard to place under either category.[19]

Nor is it easy to understand the remarkable irregularity in the date at which following appears, according to different records, as will appear from the table below (compare also that on

[18] Comparative Observations on the Development of Movements, p. 1; Mental Development of a Child, p. 45.

[19] "5th day.—He plainly tried to follow a lighted match with his eyes, but was successful for a few inches only. On the 8th day a white handkerchief was held before his face, then moved slowly to one side. He moved his eyes jerkily to keep it in range, but could not follow it more than a couple of inches on each side." Mrs. Cooley, MS. record.

"8th day.—He was seen to focus his eyes in looking at a hand. He looked fixedly at the hand when it was quiet, and followed it when moved. (Here unfortunately the notes have failed to record whether or not his eyes maintained their focus while following the hand, and the plane and direction in which the hand was moved.) . . . 10th day.—His eyes followed the hand of a person beside whom he was lying, five times in its course back and forth across some sewing." Mrs. Moore, *op. cit.*, p. 45.

p. 76). We need more continuous and detailed reports of the development of vision before we can determine the true place of this movement in its history.

TABLE IV. FOLLOWING A MOVING OBJECT WITH THE EYES.

STAGES OF THE MOVEMENT.	DATE.	OBSERVER.
Unfocused reflex following bright objects	2d day	Genzmer, Moore.
	3d day	Daniels.
	5th day	Cooley.
Light fixated and followed	5th day	Moore.
	3 weeks	Talbot papers, Case A.
	4th week	Preyer, Sharp, Shinn (nephew).
	5th week	Shinn (niece).
	6th week	Talbot papers, Case D.
Object other than a light followed	8th day	Moore, Cooley.
	2 weeks	Daniels, Alcott.
	3d week	Tilley, Conard.
	3 weeks	Wood.
	4th week	Shinn (nephew).
	5th week	Catterall, McLeish, Hall.

Co-operation of Neck Muscles.—In both the preceding eye-movements,—turning the fovea upon an image at the margin of the retina, and following an image with the fovea,—I saw a good co-operation of the neck muscles with those of the eye; not a mere primitive rolling of the head toward stimulus, but a well-adapted movement to increase the range of the eye in seeking the image. In the first instance the head was thrown backward; in the second, turned far to the side. Preyer,[20] Mrs. Moore,[21] Mrs. Sharp,[22] Mrs. Conard[22] and Mrs. Catterall[22] mention movements of the neck in looking,—in two cases, at least, evidently the same new, well adapted movement that I observed.[22a] Here we seem to see the neck muscles coming under cortical control almost simultaneously with those of the eye, and their motor centers drawn into the same association group with those of the eye. It is possible, however, that we have still only

[20] *Op. cit.*, p. 44.

[21] Comparative Observations on the Development of Movement, p. 1; Mental Development of a Child, p. 46.

[22] MS. records.

[22a] My nephew made the movement, faintly and imperfectly, from the 4th week.

a reflex, acting upon a more delicate and complex stimulus than at first; still more likely that the movement is a transitional one, the former reflex act initiated by a hedonic impulse, but completing itself automatically,—adopted as a whole into the association group, so to speak. It is a simple movement, requiring no such adjustment to distance and direction as the eye-movement does.

Period of Practice in Active Looking.—Psychically a great advance is apparent with the beginning of looking, whether that date from "following" or from turning the eyes on the marginal image. The association groups now forming involve not merely a primitive recognition of former experience, as in the earliest type (p. 54), but a growing desire and volition. The important step has been taken of *bringing into one the testimony of two disparate senses by a voluntary movement.* The visual experiences have taken on the undoubted character of perceptions, though the content of the perception is nothing more as yet than an undefined light patch; and it is worth noting that with the very first active look, I noticed a marked increase in intelligence of expression, and that the same thing was noted by Preyer, and is in some way indicated in the notes of most observers at this period. In the weeks following, the voluntary exercise of the sense of sight, and the psychic development under its influence, show steady expansion. Both Preyer and Mrs. Moore mention the pursed lips, showing strain of attention in looking; and I saw the same thing, with marked tension about the brows.

The pleasure in the exercise of vision at this stage is reported over and over by all observers,—demonstrations of joy in glitter, in strong chiaroscuro, in moving and vibrating objects, and in the human face, with its changing high lights.[23] In all direc-

[23] *Op. cit.*, Preyer, pp. 45–46, also Conspectus, in The Development of the Intellect, pp. xii, xiii; Sully, pp. 402–403; Mrs. Hall, pp. 458–459 (January, 1897); Mrs. Moore, pp. 6, 45–47; Hall and Smith, pp. 320–321; Mrs. McLeish, p. 111; also MS. records of Mrs. Tilley, Mrs. Cooley, Mrs. Cook, Mrs. Beatty, Mrs. Daniels. Cf. also my The Biography of a Baby, pp. 78–92. Mrs. Tilley noted of both her children that they would stop crying to look at patches of light or other interesting sights; the same thing was true of my nephew.

tions the conscious life is enlarging at the same time: sensori-motor action appears in the limbs; rudiments of emotion appear, and expression of pleasure or discomfort becomes more vivid and various; new instances of "associative memory" are noted.[24] This is the period (covering almost exactly the second month, in the case of my niece), during which Flechsig found the association systems in the hemispheres taking on medullation in considerable number.[25]

It is a period of practicing and perfecting the power of active looking. By its close, the baby was looking about freely from point to point within the field of vision, and following of her own accord the motion of objects at a proper distance; the eyes were fairly well focused for fixation right and left, up and down; and perceptions of *direction*, estimated in terms of two senses, were becoming systematized. But there could have been no perception of *depth* in space until the lenses could be adjusted to varying distances.

3. ACCOMMODATION.

Beginning of the Power.—It is not easy to fix the arrival of this important development. A reflex movement of accommodation, as we have seen (p. 28), can be forced very early, but does not involve the real visual adjustment of the lens to the distance of the object, for better seeing,—an adjustment probably reached only after many involuntary experiments in the converging and diverging of the eyes, accompanied by reflex alterations in the shape of the lenses. Out of the associations of these movements with the resulting visual appearance, comes the ability to adjust the eye for the distance of clearest seeing, exactly as happened in the case of learning the adjustment for direction. But the movements of the eye in accommodation are so minute and hard to observe that I know of but two or three

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[24] The Biography of a Baby, Chap. V.

[25] Ueber die Associationscentren, Proceedings International Congress of Psychology, 1896, p. 59.

observers who have fixed the date of the development with any degree of certainty.[26]

I believed that I saw the beginning of the power in my niece at eight weeks old, when she looked back and forth, from one face to another, at a different range of distance from her, with a marked interest and attention that showed both faces were fairly clear to her sight (I, p. 15). Certainly there was every indication that some important advance in vision took place at this time, for there was an immediate and noticeable increase in earnestness in loking about, followed by unprecedentedly long periods of sleep, as if from fatigue due to the crowd of new visual impressions.[27] There was also an immediate increase in the effort to hold up and balance head and body, and by the tenth week the baby sat habitually, propped with cushions, straightening up her back, holding her head erect, and turning it about to look this way and that,—a rapid advance in muscular control that bore every appearance of being stimulated mainly by the craving for visual enjoyment (I, pp. 325-327).

Reaction to Threat at Eye.—In the same week in which Professor Preyer observed signs of voluntary accommodation, he saw the first winking reaction when he thrust his head suddenly near the baby's eyes; I saw it on the same day in which I inferred the beginning of accommodation. All reports that I can find of its appearance place it somewhere near the same date.

[26] Preyer places the first voluntary accommodation in the 9th week (*op. cit.*, p. 54). Mrs. Tilley had good evidence of it at 7 weeks. Mrs. Saunders's boy in the 7th week followed persons with his eyes as they went into an adjoining room, but whether he kept the eyes well focused is not recorded. Sully speaks of "unpleasant squinting-like failures" in trying to converge the eyes on a near object, before the 6th week, and seems tc regard accommodation as attained at 6 weeks (*op. cit.*, p. 402), but gives no observation in support of the opinion. Mrs. Moore reports accommodation " fairly good " in the 5th week; my nephew at the end of the 8th week followed movement toward and from his eyes, keeping the focus fairly well.

[27] I have said, I, p. 257, that sleep did not seem at any time to be affected by mental fatigue. In re-examining my notes for the later book, The Biography of a Baby (q. v. pp. 93–97), I first noticed how closely on the date of accommodation the increased visual effort followed, and upon this in turn the long sleep. Mrs. Tilley also notes remarkably long sleeping—twelve hours on a stretch—in the week or two following the appearance of accommodation.

TABLE V. DATE OF REACTION TO THREAT AT THE EYE.[38]

DATE.	OBSERVER.
Forty-first day	McLeish.
Forty-third day	Hall.
Seventh and eighth week	Soltmann (cited by Preyer).
Fifty-sixth day	Shinn (niece and nephew).
Fifty-seventh day	Preyer.
Before two months	Cook.

This reaction certainly does not indicate fear, but rather a faint shock from a sudden sensory impression; and there seems no reason why it should have been absent in the early weeks of life, and now appear, unless the child has become newly capable of some visual impression, not before received. If this new susceptibility be due to the power of following by accommodation the approach of a body toward the eyes, and perceiving with some distinctness its sudden expansion across the field of vision, the noticeable winking reflex gives us an easy means to fix the date of accommodation.

Growing Adjustment to Distance.—The adjustment to distance, like that to direction, is no doubt only beginning at the time it is first noted, and continues for a long time imperfect. At what date it is perfected, I know of no way of determining. Some indication is given by the slow increase of the distance at which objects were noticed. It was the twelfth week before my niece gave any attention to an object across a room (some 15 feet away, that is); and the fifteenth week before she did so habitually,—having learned, in the three weeks intervening, to follow the movement of people crossing the room, receding and

[38] Sigismund says that some children do not wink at an attacking finger even in the 16th week, and as Preyer points out (*op. cit.*, p. 27) this is clearly due to the small area occupied by the finger. The dates in the table are all based on a threat made with head or hand. I found that a thrust with the head produced the reflex earlier than one with the hand; Mrs. McLeish mentions the same thing, and it seems implied in Preyer's note. It requires, therefore, a progressively less stimulus to excite the reaction as the child grows older. Conversely, it is shown by Mrs. Hall's careful note, as well as by Preyer's, that upon a fixed stimulus the reaction becomes progressively stronger till it is complete—one day a slight tremor or the lids, next a more marked one, next actual winking. This gradual development can not be due to increasing permeability of the reflex arc, for even at birth this shows itself perfectly permeable to such stimulus as the retina is then capable of receiving; it must be due to some new and gradually acquired retinal susceptibility.

approaching. Up to the fifth month she rarely watched anything more than fifty feet outside the window. The distance at which she noticed and recognized increased steadily (for some time only as her eyes were *led on* by following large receding objects), and I saw no indication within the first year that she ever looked really far away, into the distance. In the latter half of the second year she certainly did not distinguish distant objects as clearly as the adults about her did (I, pp. 19–21). But in all this matter of distant seeing, other considerations come in besides that of the mere effectiveness of accommodation: viz., the growing vividness of visual images, and of clearness in retinal definition; and the development of attention, ability to interpret, and apperception.

Preyer, Sully, Mrs. Hall, Mrs. Moore, Mrs. McLeish, and Mrs. Wood have all noticed the increase in distance range of perception after the first three months. It is not easy to make any systematic comparison of the rate of increase, for all the notes except Mrs. Hall's are quite fragmentary, and in some cases the distance of perception, in others that of recognition, is recorded. The following summarizes fairly well all that I can find on this point:—

TABLE VI. Increase in Range of Vision.

DISTANCE OF PERCEPTION.	DATE.	OBSERVER.
Persons recognized or noticed across room, 10 to 15 feet...	12th week	Hall, Shinn (habitual by 15th week).
	3 months	Wood.
	14th week	Tilley.
	Late in 4th month	Sully.
Objects 100 feet away attract attention[29]	25 weeks	Shinn (niece and nephew).
	33d week	Hall.
	9th month	McLeish.
	51st week	Preyer.
Objects watched a block away..	27th week	Moore.
Moon noticed	6th month	Cook.
	At 12 months....	Shinn.

[29] In the 33d week Mrs. Hall's boy greeted his father with outstretched arms at a distance of 200 feet; while my niece up to the 85th week misnamed acquaintances at 100 feet—not, however, I thought, from defect of distant seeing, but from failure to fix on the proper traits for distant recognition (I, p. 21). In the 9th month Mrs. McLeish's daughter did not seem to recognize faces more than 75 feet away.

First Visual Idea.—In the incident of the 56th day that led me to suspect the presence of voluntary accommodation,—viz., looking from one face to another at unequal visual range,—there was involved another important advance, besides the mastery of the visual apparatus. The faces were so far apart in angular distance as not to be in the field of vision at the same time; in looking from one to the other it was necessary to turn the head and *look for* what was out of sight. A visual idea had therefore been formed. It is not to be supposed that at this stage the idea could have been held for many minutes; nor that it implied any such conception as that of the objective existence of the unseen face: the movement to bring this to sight no doubt followed an impulse arising from simple association. But with all the limitations, the incident revealed a growing representative element in the visual and motor associations, an enlarging psychic complex into which they were becoming knit.[30]

Period of Practice in Accommodation.—During the whole of the third and fourth months the baby was constantly looking about, and exploring the visual field with diligence and eagerness; it remained her principal occupation till grasping was established.

Are we to suppose that during this period she saw objects in clear definition, or still only as unoutlined regions of light and shade? Recognition of a face was reached possibly by the 60th day, certainly by the 80th. The ninth week seems about the usual date. The following are the recorded dates I find for

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[30] The parallel incidents that I find in other records are as follows:—

"39th day.—As the child lay looking at the wall, which was illuminated by lamplight, his father's head was so interposed as to cut off his view. Thereupon he moved his eyes, and afterward his head, in order to see again the wall behind the obstacle." Mrs. Moore, Mental Development of a Child, p. 46.

"11th week.—The child looked repeatedly, and as if comparing them, from the face of one person to that of another." Same, p. 47.

"73rd day.—Lying on my knees looking at the fire, he turned his head clear around and looked up at me." Mrs. Catterall, MS. record.

See also Sully, *op. cit.*, p. 405.

recognition of a familiar face,[31] or evident discrimination between familiar and unfamiliar:—

TABLE VII. DATE OF RECOGNITION OF A FACE.

DATE.	OBSERVER.
Before eighth week	Sully.
Ninth week	Hall (58th day). Moore (60th day). Meade. Wood. Shinn (?). Tilley (eighth to tenth week?).
Tenth week	Daniels.
Eleventh week	Alcott.
Twelfth week	Shinn (if not ninth week).
Three months	Sharp. Wood.
Fourth month	Cook.
At four months	Hoyt.
With the second quarter year	Sigismund.

But the recognition of a familiar face does not prove that the outlines have been clearly distinguished. The grouped high lights in a face, which attract the baby's attention so early and so strongly, are characteristic enough in each one of a few familiar home faces to make recognition no difficult matter, without the help of any outlines,—especially when (as in the case of my niece's first unmistakable recognition) there are such marked features as long white beard, spectacles, and shining bald head; and as late as the seventeenth week I was doubtful how far the baby recognized any one except her grandfather.

There was, indeed, no indication at all, up to the thirteenth week, that anything except bright, moving, or lighted things,—

[31] The first object recognized is almost invariably a face; next comes recognition of the breast, nursing bottle, spoon, cup, etc., about a fortnight later (Tiedemann, Sully, Mrs. Hall, Mrs. Moore, Mrs. Tilley, Mrs. Cook, Mrs. Catterall, Mrs. Crew).

steel buttonheads in a canopy over her, a dangling bunch of gay sachets, shadows flickering on the ceiling above the chandelier, the leaves of a note-book fluttered before her, silver napkin-rings rolled on the table, the bright, changing oval of the human face, had ever attracted my niece's attention. I will go so far as to say that, not only in my own record, but in the score of others I have examined, I have found no instance of interest in vision, up to about the end of the first quarter-year, which might not have been due to the illumination or the motion of the object, or to its being thrown into strong chiaroscuro.

The growing power of accommodation would add greatly to the pleasure of such sights, and especially of human faces, for it would enable the child to keep them in good range, as they moved from or toward her; but before surfaces could be distinctly delimited, so that the different plane forms of objects could interest and occupy the baby, and could become a means of discrimination and recognition, the art had to be acquired of running the eye about the outlines,—an art not so promptly picked up even by the adult when relieved of congenital blindness by an operation.[32]

My own impression, after close comparison of all the indications in my notes, is that for about half of this two-month period (third and fourth months) of incessant visual exercises and absorbing visual interest, the baby was occupied mainly in the practice of accommodation, bringing patches of high light, bits of glitter, or moving and twinkling objects, from all about the room, to the range of best seeing, and learning to turn and look for them everywhere, and follow them as they approached and receded; but that shortly before the end of the third month (about the time, that is, that accommodation was fairly perfect within the range of a single familiar room, though still untrained for longer distances) the *forms* of objects began to attract attention.

4. PERCEPTIONS OF PLANE FORM.

The strong projection of a light surface against a dark, or of a dark one against a light, would almost inevitably sooner or

[32] Preyer, The Mind of the Child, Appendix C.

later lead the eyes to follow along the edge of high light, and it is likely that here, as in other cases, the human face was the baby's first teacher, and also that a familiar outline was first traced repeatedly, before she began to seek new ones, looking from object to object.

At all events, it was in the twelfth week that I was struck by a peculiarly sober behavior as the child looked about. In other respects this week and the following weeks were a period of notable vigor and gayety with her, but in her visual exercises she showed new effort and mental tension. In the thirteenth week I saw her, for the first time, look attentively at an object that was neither lighted up, brightly colored, nor in motion,—a rattle, which she held in her hand. At fourteen weeks old she had a remarkable expression of *surprise* as she looked around with wide eyes; and this I noted increasingly for several weeks. The eyebrows were lifted, and the expression of eagerness and effort to comprehend was conspicuous; she would look about silently thus for many minutes at a time.[33] At this period persistent efforts were made to rise to the sitting position, apparently (in part at least) for the sake of better seeing (I, pp. 328–329).

In the seventeenth week, when held in the arms, she would exhaust one quarter of the room with this eager inspection, then turn her head and begin on another quarter. Carried to another side of the room, she would renew the eager inspection from the new point. Objects that had been in the room ever

[33] Mrs. Tilley records of her younger child, at the same stage of development (12 weeks, about three weeks after accommodation was well attained): "It seems as if he could not open his eyes wide enough to see all he would like to. He just looks, and looks, and looks all around moving his head from side to side like a little bird." I do not find mention of this period of serious visual investigation in other records; but there are fragmentary indications of it in the notes of Alcott (Talbot papers, p. 10), and of Mrs. Moore (p. 48), and also in Mrs. Tilley's MS. notes on her elder boy. It has been conspicuous in my nephew, in the 4th month. Looks of surprise in a *new* room are often noted. One exceedingly precocious child is reported as early as four weeks old to have been almost unmanageable in a new room, from visual excitements, and invariably to have had nervous tantrums afterwards (Mrs. Daniels).

since her birth were newly discovered, and regarded with attention,—a fan here, a picture there.

Since with every movement objects alter in their plane form as projected to our eyes, a baby—quite unable to infer the permanent solid form of each chair, table, or vase, and beginning to trace out plane form with his eyes—must live in a perfect kaleidoscope of shifting shapes. My niece's surprise, her eager tension, her apparent effort to bring things into some sort of mental order, the renewal of inspection, as if a new room had been entered, when I carried her to a new part of the room, and all this during the very weeks immediately following on the full mastery of the mechanism of vision,—these reactions seem to me to point to no interpretation except that she was during this period discovering the objects about her and becoming familiar with their different outline aspects.

When this familiarity was once attained, the eager study of the surroundings declined, to be renewed in new rooms. So, too, a face, seen daily all her life, but not intimately about her, was apparently discovered for the first time at four months old, with an expression of absolute amazement, jaw fallen and brows raised; and then daily watched with excitement and surprise, till it, too, became familiar.

5. EARLY VISUAL-MOTOR INTERPRETATIONS.

Direction and Position.—Not only the outlined form of objects, but also their directions and relative positions, must have changed to the baby's eyes with every change of her own position. I never saw any indication that this shifting of place was observed; the brain probably did not at this time take in any such perception as that of a *group* of things, whose individual members were distinguished, with their relations of distance and direction.[34] It is certain that I never noticed at this time (nor has any one else recorded) any instance of attention to the displacement of a piece of furniture,—a thing that often excites lively attention in an older baby.

[34] If we except that simple and most familiar group, the features of a well-known face. Mr. Alcott's baby at this stage of development was terrified at sight of a distorted face.

Undoubtedly, however, some feelings of direction were forming in connection with the passage to and fro of images across the retina, and especially when people whose movements the baby was following passed out of the field of vision, to right or left. Once, as early as the thirteenth week, she turned and searched about repeatedly for a person who had passed around behind her, showing that she had formed some idea of the general region in which the visual experience might be recovered; and in the fifteenth week, she was constantly following the movements of people to and fro. In the last days of the fourth month, sitting by a window, she showed great surprise to see a person disappear through a door and reappear to her sight outside through the window; and the surprise showed that she had formed some sort of expectation as to where and how people would appear and reappear, which could be jarred by a novel phenomenon. Of any ability to project a line of direction, to conceive direction beyond the immediate range of the eye, I saw no indication in the first four months.

Distance Estimate.—Of distance as measured by the reach of her own arm, or by the effort of locomotion to a place, the baby could at this stage have had no idea; but she was by no means without data for distance measurement. The feelings of passive movement when she was carried to and from objects, and the corresponding changes in feelings of accommodation in her own eyes, associated with the parallel changes in definition and in apparent size of the objects (now that she had acquired accommodation and the ability to see objects in good definition), certainly afforded material for beginning the long and slow process of estimating distances.

Probably she went no further in this process, within the first four months, than to notice the striking changes in apparent *size* caused by distance. How great these changes are one hardly realizes (accustomed as we are to correct them by experience) till he measures the comparative angle subtended in his own eye by an object at arm's length and one across the room. And consider how conspicuous they become when a light body is projected against a dark wall, or the converse; or when some

object of interest is gradually blotted out to the child's eye by the spreading image of an approaching body, or uncovered by the contracting outlines of a receding one. That my niece did, in fact, notice such changes, I thought indicated in the seventeenth week, by a special interest and curiosity with which she surveyed our faces across the room.

It is possible, too, that some association may have already gathered between the visual changes passed through by an approaching face and the immediately following experience of friendly attentions,—that is, that the baby could tell when a person was coming toward her; but I have only doubtful evidence of this. In any case, such inchoate associations as these are far enough from any real interpretation of distance.

Identity of Objects.—There is still a third inference for which visual-motor perceptions alone might supply material,—that of the identity of an object, seen in all its aspects, from its different sides. The face, the back, the side, the near and the remote aspects of a familiar person, seen over and over changing into each other as he recedes and advances and turns, and associated with his customary behavior, must in time come to be perceived by a baby as belonging together in an invariable group. So of familiar inanimate objects, as the baby is carried to and fro, or sees them moved about.

How far such grouped visual perceptions could ever fuse into a single perception of the object as one and the same thing, we can only guess, for, in fact, the process has scarcely begun before it is superseded by a far more efficient one: the separate development of visual-motor and tactile-motor perceptions is ending, the two types of perception begin to coalesce, and the world is hereafter studied with the threefold parallax of visual, muscular, and tactile sense.

So it was in the case of my niece at least: at four months old, when she was but just in a position to begin the process of identifying objects by the eye alone, she was on the verge of acquiring the power of grasping, which was to bring the whole mass of her tactile-motor perceptions to bear on them in cooperation with the visual-motor ones.

Nevertheless, the coalescence of the two types of perception proceeded slowly, and even after it had begun, I saw evidences that a process of unifying objects by the eye alone was in fact going on. In the nineteenth week the baby showed perplexity and amazement over the alternate presentation of the side and the front of a familiar face (I, p. 86); yet this transformation and similar ones had been seen a thousand times before, without surprise or attention. Unquestionably some effort to *comprehend* the phenomenon, to apperceive it newly, was now taking place. I must have had a single glimpse here of a process of identification (or of association-grouping that tended toward identification) which had been going on for some time already, and continued for some time afterward. A week later the baby showed a well-formed expectation of her grandfather's face at sight of the back of his head (I, p. 86).

This development belongs logically here, as the latest unaided visual-motor interpretation; but in date, as I have said above, it lies just beyond the period to which this section is limited, that of separate visual-motor and tactile-motor development.

6. SUMMARY AND TABLES.

The process of learning to see, then, as I traced it, was as follows:—

First: In the newborn condition, lasting some ten days, the baby received passive sensations of light, and the eyes were directed hither and yon without purposiveness by spontaneous motor impulses; reflex or spontaneous movements of accommodation also took place now, or at least before voluntary accommodation.

Second: From the 2d to the 5th week lighted surfaces, accidentally encountered, held the eyes by a very primitive and automatic action of the hedonic impulse.

Third: In the 3d week the eyes recurred to favorite spots, still under control of an automatic, but more developed, hedonic impulse.

Fourth: (*a*) At 24 days old, active looking began, by the movement of the eye to bring an object from the margin to the center of the field of vision.

(*b*) On the 33d day an object in motion was followed perfectly with the eyes,—a case coming under the preceding head; viz., active looking; and perhaps normally an earlier form of the development.

Fifth: A period of practice followed, lasting from about the 4th to the 8th week, during which active looking was perfected, and reflex or chance movements of accommodation were developing toward voluntary ones, under the selective guidance of the hedonic impulse.

Sixth: At 8 weeks old voluntary accommodation began, and became fairly perfect by the 15th week, for short distances (width of a room),—developed largely by following the movements of people as they approached or receded.

Seventh: From the 12th to the 17th week perceptions of plane form were rapidly developing, as the eye became able to trace outlines and delimit surfaces.

Eighth: From the 15th week on, associations were forming on which later perceptions of distance and direction rested, and a beginning was made of the recognition of objects as individual wholes, in all their different visual aspects,—perhaps only, so far, of a few familiar human heads.

Each stage of progress after active looking was attained was followed by a marked expansion of intelligence, and increase of interest and enjoyment.

Here we start out with (1) *passive sensations of light,* and (2) *automatic eye movements with their accompanying muscular sensations;* and see this raw material worked into a complex power of active vision, in a few months, by *the successive grouping together of associations under direction of the feeling of enjoyment.*[35]

In the foregoing summary I have filled out the continuous line of progress, inferring transition (or practice) stages where they

[35] With an intimate co-operation at every step, of a developing memory image, and a developing voluntary motor control. Such an analysis as the foregoing brings into strong relief the impracticability of distributing a biographical record into strict categories of Feeling, Intellect, and Will, or other divisions of human faculty (p. 10).

were imperfectly observed. The following table gives a summary of the stages as specifically recorded, compared with those recorded by the three other observers whose records are consecutive enough to be used:—

TABLE VIII(*a*). Development of Active Vision.

Age of Infant.	Stages of Development, Observed by			
	Shinn.	Preyer.	Hall.	Moore.
1st week.	Mere sensibility to light, with spontaneous and reflex movements of eyes and neck.			2d day, Unfocused reflex following with the eyes.[36] 7th day, Eyes turned from one bright surface to another.
2d week.	Fixed gazing begins.[37]	Turning face from one bright surface to another, in field of vision, with fixed gazing.	Fixed gazing begins.	8th day, Fixed gazing begins. 10th day, Following an object back and forth.
3d week.	Recurrence of gaze to favorite spots.[38]			
4th week.	Looking from one light surface to another. Beginning of intelligent looking[39] (at 24 days).	Following bright, moving object with eyes. Beginning of intelligent looking (23d day).	Looking from one object to another, back and forth. [Intelligent looking.] (28th day.)	Spontaneous following object in motion (28th day). Attention and interest roused by sights [intelligent looking].
5th week.	Following a bright, moving object with eyes (33d day).		Spontaneous following object in motion (32d day).	Looking from one light surface to another (30th day). Accommodation (31st day).
6th week.	Spontaneous following object in motion (40th day).			
7th week.		Spontaneous following objects in motion.	Winking at sudden approach to eyes.	
At 8 weeks.	Accommodation. Winking at sudden approach to eyes.[40]	Accommodation. Winking at sudden approach to eyes.		

[36] Mrs. Daniels reports the same on the 3d day, Mrs. Cooley on the 5th day. For fuller comparison of various records on the subject of following, see Table IV, p. 61.

[37] Darwin, Alcott, Mrs. Tilley, and Mrs. Cooley also report fixed gazing as beginning in the 2d week; Sully alone reports it in the 1st, and Champneys at "a week old."

[38] 5th week, Mrs. Cooley.

[39] Mrs. Tilley and Mrs. Beatty seem to date the beginning of intelligent looking in the 5th week; Sigismund 7th to 10th week in his own boy, 5th week in a little girl known to him. I date it 5th week in my nephew.

[40] Mrs. McLeish, 6th week; Soltmann, 7th and 8th; Mrs. Cook, end of 2d month; Shinn, nephew, 8th week.

Sully places accommodation in the 6th week, Mrs. Saunders in the 7th. Mrs. Tilley at 7 weeks.

All the records agree as to the expansion of intelligence, the access of enjoyment in sight, and of expression in the countenance, that follows each step in development, after the first active looking.

It will be noticed that Preyer's record, Mrs. Hall's, and mine, are in pretty close agreement, both as to the order of development and its rapidity, but that Mrs. Moore's differs decidedly. It will be noticed, too, that the main discrepancies concern the date of following a moving object (p. 61). If we eliminate this discrepancy by considering intelligent following with the eyes the same development, essentially, as intelligent direction of the fovea to the marginal image, and drop out minor stages, we get the comparative table given below:—

TABLE VIII(*b*). TABLE VIII(*a*) CONDENSED.

Age of Infant.	Stages of Development, Observed by			
	Shinn.	Preyer.	Hall.	Moore.
1st week.	Mere sensibility to light, with spontaneous and reflex movements of eyes and neck.			2d day, Unfocused reflex following with the eyes. 7th day, Eyes turned from one bright surface to another.
2d week.	Fixed gazing or staring begins.	Face turned from one bright surface to another.		Object followed back and forth [automatically].
3d week.	Recurrence of gaze to favorite spots.			
4th week.	Intelligent looking begins			
5th week.				Accommodation.
7th week.			Winking at sudden approach to eye Accommodation.	
At 8 weeks [40a].	Winking at sudden approach to eye. Accommodation.			

If I may be permitted to restate this table once more, in such fashion as to bring in the evidence of more fragmentary records, a still stronger agreement comes out as to the main stages of development and their order.

[40a] Shinn, last day of 8th week; Preyer, first day of 9th.

TABLE VIII(*c*). TABLE VIII(*a*) AND (*b*) RESTATED.

STAGE OF DEVELOPMENT.	DATE.	OBSERVER.
Fixed gazing	1st week	Sully.
	At 1 week.....	Champneys.
	2d week	Darwin, Preyer, Alcott, Shinn, Hall, Moore, Tilley, Cooley.
Directing the look (including "following"): Beginning of intelligent looking	4th week	Preyer, Shinn (niece), Hall, Moore.
	5th week	Sigismund (girl), Tilley, Beatty, Shinn (nephew).
	7th–10th week..	Sigismund (boy).
Accommodation	5th week	Moore (?).
	6th week	Sully (?).
	7th week	Saunders, Hall (?).
	At 7 weeks.....	Tilley.
	8th week	Shinn (nephew).
	At 8 weeks.....	Preyer, Shinn (niece).

II. THE TACTILE-MOTOR ASSOCIATION SERIES.

This series of associations is not so easy to trace consecutively as the visual-motor one, since more organs are concerned,—mouth, hand, and arm, as well as the neck, which co-operates to a certain extent; and each one develops its own set of associations between tactile and muscular sensations in a somewhat overlapping order of time. The comparative data from other records, too, are more meager here.

1. GRASPING AND ACTIVE TOUCH WITH TONGUE AND LIPS.

Grasping.—In the fourth week I saw the first sign of any possible touch association. Up to this time sucking movements had taken place as a pure reflex, discharged by the touch of a suitable object in the mouth. Now they were suggested (when the child was hungry) by the external contact of a hand or cheek against her lips. At the same time, the lips were protruded and seized the skin that touched them.

This looks like a voluntary act, directed by an association already established between the warm, soft touch of the breast against the lips, the muscular sensations of the seizing and sucking movements, and the resulting satisfaction of hunger; and

there had been abundant opportunity for unconscious practice of the movements, as the nipple was placed in the mouth and withdrawn, or as the baby's own hands chanced to get in and out of her mouth. Yet it is not unlikely that the whole action was only an extension of the original sucking reflex. Preyer plainly implies that it is to be seen in the newborn period,[41] and Mrs. Moore reports that her daughter, on the 4th day, could seize the nipple again when she had lost it from her mouth.[42] Even as late as the fourth week, when I saw the movement, its manner was mechanical, quite unlike that of the active looking which began in the same week. It may perhaps be a movement analogous to that of the neck noted about the same time (p. 61), "the former reflex act initiated by a hedonic impulse, but completing itself automatically,—adopted as a whole into the association group, so to speak."[43]

Active Touch.—In the seventh week the baby was often seen passing the tip of her tongue in and out between her pursed lips, with an appearance of attention and interest. Here was real active touch. A true association had been established between tactile and muscular sensations that had often been felt together and enjoyed, so that here again, as three weeks earlier in the visual field, we have *the testimony of two disparate senses brought together by a voluntary movement.*

The association was anatomically very simple, all the sensations belonging to the same cortical region (the "Körperfühlsphäre" of Flechsig); and it was the more easily formed because the touch sensations that entered into it were double

[41] *Op. cit.*, p. 260.

[42] Comparative Observations of Movements, p. 6.

[43] Movements of groping with head and mouth, as if seeking for the nipple, are often noticed in the hungry child during the early weeks. They have been seen quite perfectly developed on the 5th day after birth in a child born in the 7th month, and a "bottle baby" at that (MS. notes of Mrs. Chapman). Here we can have nothing but an automatic movement, due to the heightened reflex excitability of hunger. Later it seems to be utilized as a voluntary seeking, in aid of the mouth-grasp, but I know of no observation that traces the process of change.

From the end of the 8th week (56th day), my nephew began to make efforts to seize with the mouth (without visual guidance), at suggestion of touches about the lips.

ones, proceeding from both the touching surfaces, lips and tongue, which must have emphasized the experience in consciousness. The movement, too, was very simple, scarcely more than a repetition of one that had many times been made as part of the act of sucking, when the lips and tongue were protruded somewhat to seize. But I had no doubt, in observing it, that it was an intelligent act, performed for pleasure in the sensations experienced, not a mere mechanical repetition.

Whether it was preceded by such incipient stages of association as I traced in the visual series,—by a mechanical arrest of the movement of the tongue through pleasure in the touch of the lips, or by its mechanical recurrence to them after chance experiences of the touch pleasure,—I can not say. Probably it would be impossible for the closest observation to discriminate stages so precisely, amid the many vague movements of the tongue and lips. In any case, I failed to watch the mouth closely, not knowing that here, instead of in the hand, I must look for the earliest appearance of active touch and grasping.

It is noteworthy that the first distinct synthesis of sensations in the tactile-motor field occurred so much later than the corresponding one in the visual-motor field (the one in the seventh week, the other in the fourth). Considering that the tactile sensibility of the tongue, lips, and fingers is lively from birth, and that these organs are highly motile, continually responding to involuntary impulses, and encountering contacts on every side, it might be supposed that their tactile and muscular sensations would be early associated. That they are not, as compared with the light sensations and those of eye-movement, may be in part because the eye is even more motile than the tongue or hand, and light even more continuous than contact; in part because sensations of touch rouse less lively interest in a young infant than those of light. But I think it mainly due to the fact that the baby comes into the world with a complex touch reaction—that of sucking—already perfectly established on a lower level, requiring no suggestion through cortical associations; and this function not only meets all organic need, but also the hedonic demand, for it plainly gives pleasant sensations from the first.

A fortnight later, in the ninth week, the baby would put out her tongue and lick a cheek against which her lips were laid (I, p. 386); again (as the manner showed) a movement voluntarily initiated for pleasure in the sensation of active touch, but in itself a ready-organized inherited reaction, which has been seen as early as the first day of life.[44]

I have scarcely been able to find in the records of other observers any note of these early developments of active touch.[45] I must think, however, that this is not because my niece was exceptional in the precedence of mouth over hand (a precedence eminently reasonable on phylogenetic grounds), but because other observers have been like myself occupied in watching for the first tactile development in the hand, and have neglected the mouth.

2. ACTIVE TOUCH AND GRASPING WITH THE HAND.

Active Touch.—Up to this period I had seen no sign whatever of attention to the hands, not even when they encountered each other, producing double sensations of touch; nor of any sort of control over their movements. Objects were still clasped without attention by the reflex movement of the newborn period. Now, in the ninth week, active touch began to appear; and in this case incipient stages of the association between tactile and muscular sensations were quite evident. Objects laid in the palm were clasped and held longer, and with some appearance of attention. The finger-tips were repeatedly held together when they chanced to come in contact, as though the sensations were enjoyed. Here we have two cases of the same thing that was observed as the first step toward formation of visual-motor associations,—the arrest of movement under influence of attention and pleasure, thus prolonging the pleasant sensation, and deepening the channels for later voluntary action (pp. 51–52).

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[44] Preyer, *op. cit.*, p. 118.

[45] Mrs. Tilley's boy, in the 7th week, had a habit of licking his dress and his fists. By the end of the 10th week, I became satisfied that my nephew was entertaining himself by moving his tongue and lips over each other, and it was quite evident in the 11th.

In the twelfth week, true active touch in the fingers began,—and began exactly as it had in the tongue, by the attentive repetition of a familiar movement, originally reflex. The hands were clasped and unclasped, so as to brush the finger-tips across any surface on which they chanced to be resting,—a sort of contact that had over and over been felt as the hand closed automatically. The child's manner was attentive, and the movement seemed clearly voluntary. It was practiced for several days.

I find no mention in any other record of the arrest of movement upon contact of the finger-tips; but the prolonged and more attentive clasping is noted in several;[46] and also the first exercise of active touch with the finger-tips by fumbling movements over some surface (Table IX, p. 100).

Grasping.—Meanwhile another hand development was taking place,—the association between touch sensations and muscular sensations in hands and fingers, by which voluntary laying hold of objects became possible.

In the ninth week, as I have said just above, the primitive reflex clasping became longer and more attentive,—a development in the direction of grasping, as well as in that of active touch. Apparently the contact sensations of the whole anterior surface of the hand became thus associated with the sensations of clasping, and able to suggest the movement. In the tenth week the hand closed not only on a finger or pencil laid within it, but on folds of clothes that brushed across the palm or inner surface of the fingers anywhere. The manner of the action was highly mechanical, and the development seemed at first hardly

[46] Mrs. Tilley noted in the 6th week, together with the longer clasping, a closing and unclosing of the fingers. This might have been a mere automatic flexion and extension, such as is common earlier in the arm and leg muscles; or it might have been due to a sort of rhythmic failure and renewal in reflex responsiveness to the stimulus. But it was still a habit in the 9th week, when purely automatic movement in the hands was less to be expected; and it seems likely to have been a case of mechanical repetition of a movement under hedonic stimulus. My nephew in the 11th week, when his hands encountered by chance, would fumble the fingers against each other, roughly interlacing them; and thereafter active touch in the fingers developed rapidly.

to amount to more than an extension of the surface of reflex sensibility; it is probably like the first mouth grasping, a case of the discharge of an old reflex act, by association acquired through experience.

By the twelfth week objects were evidently "held on to" with attention and volition (I, p. 310). Before the end of the week (83d day) the clasping movement of the child's finger-tips to and fro on a tray before her had developed to a fumbling, or groping, across it, in the course of which the hand would soon encounter rattle or spools; and at the touch the article would be laid hold on and lifted,—most imperfectly, at first, but with increasing skill from day to day (I, p. 210). Even when the back of the hand was touched, grasping was suggested.

Here was plainly voluntary grasping,—intelligent action, tested by the ability to learn skill by trial and error; but grasping without any visual help, stimulated by tactile-motor ideas and directed by tactile-motor sensations. Here is also a real *seeking* for contact sensations, by repetition of movements that have previously given them (exactly as in the ranging to and fro of the eyes for light sensations just after the acquirement of active looking, p. 57); whether stimulated by mere touch-hunger in the fingers, or by an idea of the sensations to be obtained, I can not say; probably at first by the one and later by the other, for I noted a gradual increase in consciousness and intention in the manner of the action.

This tactile-motor period of grasping was distinct and prolonged in my niece's case,—perhaps because she was supplied with conveniently placed objects for grasping, a month before visually guided grasping appeared. Most records, however, have some mention of such a period.[47] Preyer mentions a

[47] *Op. cit.*, Preyer, pp. 245–246; Sully, p. 413; Mrs. Moore, pp. 15, 16; Mrs. Hall, p. 396; Mrs. McLeish, p. 118; MSS. of Mrs. Beatty and Mrs. Tilley.

The notes of Mrs. Hall, Mrs. Moore, and Mrs. Tilley, in recording this period, all mention first the habit of longer and more attentive holding, when objects have been clasped by the primitive reflex, and later the grasping upon contact (Preyer, however, in the reverse order); there is also, especially in Mrs. Tilley's notes, evidence that this grasping was at

grasping at twelve weeks old, which "looked just as if the child had purposely seized the finger," and sets it down as a reflex act, apparently only because he has not taken into consideration the possibility of any intentional grasping that is not visually directed. Sully relates an incident that showed his child able in the eleventh week to reach out and grasp an object *felt*, though he could not reach for one *seen* till he was nearly five months old. Mrs. Moore's child seems to have had a habit of ranging through the air with his hands for chance contacts and opportunity to seize, some weeks before he was capable of visually guided grasping. And so simple is the chain of association by which a child can feel for and grasp an object, compared to that by which he looks at and grasps one, that I can not avoid thinking the stage a normal one.

During the same period in which this tactile-motor grasping was developed (9th-12th week), another development had been taking place,—that of ability to direct the hands to the mouth

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first so mechanical in manner as to be scarcely distinguishable from reflex movement, and increased steadily in intelligence and intention. This corresponds with my own observation.

A period of tactile-motor grasping was clearly evident in my nephew; I give a condensed account of its development:

11th week: Clasping down no longer follows as an invariable reflex when a finger is laid in the palm, but seems to require some attention to the feeling.

12th week: Clasping takes place or not, with every appearance of volition. It seems to be suggested by the touch of the finger-tips against any surface, as well as by touches in the palm. Holding is longer and more attentive.

13th week: Touches on finger-tips plainly suggest clasping, and folds of drapery are sometimes taken hold of in this way; the child seems to have a certain intention of getting hold. The hand feels well innervated, not merely automatically responsive. Still, the manner of all hand action is still mechanical, and but slightly attentive, far inferior to visual activity.

14th week: Habitually lays hold of articles on chance contact, but only when anterior surface of hand is touched, and the object conveniently situated, so that a simple clasping movement will answer; thumb not reversed.

15th week: Increased disposition to grasp; lays hold of his blanket, dress, etc., and drags them up about his head; hands are constantly moved, as if desiring occupation, and whatever comes well into their range is laid hold of and fingered. The thumb still not reversed. (At this stage, visually guided grasping began to appear, and the tactile-motor type did not develop further. The thumb was often well reversed by the 19th week.)

at will; so that by the time the new hand-power was acquired, it could be brought into a great association group under the powerful suggestion of mouth pleasure. This parallel development, and the succeeding ones, by which hand, arm, and mouth were all brought into co-operation, I review in the next section.

3. ASSOCIATION OF MOUTH, ARM, HAND, AND NECK SENSATIONS.

Carrying the Hand to the Mouth.—Up to the ninth week the arm movements, like those of the hand, had remained, so far as I could see, wholly automatic (with the single exception related in Note 51, p. 86), differing from those of the new-born period only in their greater amplitude, and in the ease with which they were stimulated by every wave of excess energy.[48] In the usual involuntary tendency[49] of the arms to move upward, however, was given occasion daily and hourly for pleasurable sensations about the mouth, as the fingers found their way into it and were sucked, or as they passed over the delicate tactile surface of the lips, and for associating these with the sensations of lifting the arm, which invariably preceded them.

With the ninth week I began to see evidence that this association was forming, in imperfect but unmistakably purposive efforts of the hand to reach the mouth. Whether it was preceded by incipient stages, my notes do not enable me to say. I had some impression that at an early stage the hands were checked in their random movements when once they had been seized in the mouth, and sucking had begun,[50]—a case of in-

[48] This gave them, it is true, a certain definiteness of character as expressions of feeling, unlike the meaningless flexions and extensions of the newborn period.

[49] Preyer, *op. cit.*, p. 242.

[50] The evidence of recorded observations may seem rather against this. Mrs. Moore records that as late as the 10th week, when her boy was plainly trying to put his thumb in his mouth, "spontaneous movements often jerked it away—the child would cry with vexation but persevere"; and Mrs. Tilley reports of her boy at 7 weeks old, "Seems sometimes as if he were much disgusted at letting his fists go from his mouth, but does not seem to know how to keep them there." Yet both these notes imply that there was some tendency to hold the hand still, often overcome by stronger stimuli to movement, or by mere force of gravitation. And, indeed, it is often observed that children, up to a considerably later period than this, find it hard to keep the hand at the mouth, in defiance of counter-stimuli and of gravitation.

voluntary maintenance of a position under influence of pleasure; and it is probable that the earliest purposive movements of hands toward mouth that I saw were of the nature of mechanical recurrences,[51] in which the motor impulse was given by the touch-hunger of the mouth (as the eye-movements were stimulated by light-hunger), and determined along paths made easy by former experience of pleasure, as well as by inheritance. The whole behavior of the infant in the early months shows that the mouth does crave touch and muscular sensation, as the eye craves light; the highly charged cells of its sensory centers are in a continual state of tension, which demands discharge by the appropriate stimulus (p. 58, and note). Nor is this surprising, when we recall the phylogenetic antiquity and

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[51] I find several traits of mechanical recurrence in the movement. The strong tendency to bilateral symmetry in it is one. Mrs. McLeish found that in the early stage of getting the thumb to the mouth, a week before it was done "with evident intention," there was a symmetrical movement of both hands upward, ending in sucking the right thumb. "When on the 63d day, I held the left hand, she could not get the right hand into her mouth; tried many times, and at last cried" (*op. cit.*, p. 117). Mrs. Hall noticed much the same thing, even after carrying the right hand to the mouth was fairly acquired (*op. cit.*, p. 395).

I recorded, in the 7th week, one incipient stage (an abortive one) which was of somewhat different type. A pencil placed in the hand was carried persistently back to the mouth, as often as it was pushed away (I, p. 306). As I saw the ability to carry things to the mouth acquired by a visible process of trial and error, some weeks later, I could not regard this precocious act as voluntary; nor was it properly a case of the mechanical recurrence of the muscles to a habitual act. It seems rather that we have here the process of true association-making laid bare at an early stage: an incipient association was actually made, but held only long enough for half a dozen closely following repetitions of the movement.

A somewhat similar case of transitory ability to repeat a movement is given by Mrs. Moore: when her boy, in the 7th week, was sucking his thumb and the hand was removed from his mouth, if it found its way back within twenty minutes it was presented in the same way as before, so that the thumb could be seized by the mouth; but not if longer time had passed. So also from the 11th week, my nephew's hand would return directly to his mouth as often as removed, if it was released at once; but if held for half a minute, it could not.

Mrs. Moore mentions also a precocious instance of carrying an object to the mouth as early as the 5th week, which (as in the case observed by me) seems to have led to the establishment of no association.

importance of a delicate touch and motor sensibility about the entrance to the alimentary canal.

There followed a period of practice movements, in which the process of trial and error was clearly apparent, and the sensations of the successful arm movement were daily better associated with the mouth sensations, till in about a week the baby could direct her hands quite accurately, at will, to her mouth, and did it constantly. Very quickly, too, the movements of the wrist that presented the thumb were drawn into the association group, and by the twelfth week the hand was intelligently turned to put the thumb into the mouth.[52]

First Tactile-Motor Ideas.—In this arm and mouth association the sensations linked together by practice are not simultaneous, as in the case of directing the eye, but successive: the feeling of the hand in the mouth can not be had until after the arm movement has been performed. Something of a tactile *idea*, then (or, rather, a tactile-motor one, since the complex of tactile and muscular sensations experienced in sucking forms its content) is required as a part of the association.

The action stands, therefore, on a higher psychological level than that of merely directing the eye to an object in the marginal field of vision, and corresponds to that of looking for an object out of sight. The same thing is true of the groping for objects with the hand, noted in the same week (twelfth), if this groping had in fact as yet passed beyond the stage of a mere recurrence movement, under stimulus of touch-hunger alone.

[52] The notes of Mrs. Moore and Mrs. McLeish imply a different order of development here. Instead of raising the hand to the mouth, to be laid hold of and sucked just as it chanced to present itself, and later learning to turn it and present the thumb, the infant first learned, on feeling the hand touch the face by chance movement, to direct it to the mouth, and even to turn it and present the thumb, before the upward arm movement was under control at all. This seems in some respects the easier order of development—the hand first touching the face and moving across it, often reaching the mouth by chance; then guided across the face in the right direction. In this case, we should have continuous parallel series of sensations, tactile and muscular, to guide the movement, and a continuous sensory stimulus, exactly as in the case of the transit of the visual image across the retina. It was thus, in part, in my nephew's case (see note 56, p. 90).

It illustrates strikingly the precedence taken by vision over touch that after first mastering the adjustments of a more complex muscular apparatus, the visual activities are still nearly a month in advance of the tactile in taking on the ideo-motor type.[53]

Carrying Objects to the Mouth.—By the thirteenth week the ability to take an object into the hand, and the ability to direct the hand to the mouth, had become separately complete; but it required a still further development of the association group before an object could be voluntarily taken and carried to the mouth.

When the hand, after closing on an object, chanced to be lifted, it is evident that new sensations were at once experienced, besides those of contact in the hand and the ordinary sensations of motion in the arm: feelings of weight altered the whole muscular sensation of arm, wrist, and hand. When the hand chanced to be carried to the mouth, the object it held was touched by the lips and tongue, mumbled, licked, and sucked, giving rise to a variety of sensations that evidently attracted the baby's attention. By the thirteenth week, the feel of something in the hand had evidently come to be associated with these sensations, and to suggest the movements that afforded them: for objects when laid hold of were brandished with evident intention, and imperfect efforts were made to carry them to the mouth, improving day by day.

That the movement of hand to mouth, already well learned, had to be to a certain extent relearned when the arm-sensations were altered by the weight of an object, is strong evidence that the development is not purely instinctive, but requires individual experience. And the process of learning, associating the feeling of the successful movement, in trial after trial, with the desired sensation, was here remarkably clear. As the objects held in the baby's hand were not inspected visually, nor felt over, there could have been no conception of their extension out-

[53] It was probably because of the inability to form a tactile-motor idea that the precocious ability to lift the hand to the mouth in the 7th week (p. 86, note 51) failed.

side the hand to guide in turning them and directing them into the mouth; they could only be lifted again and again, striking the nose or cheek, lying across the mouth, until the right combination of movement in arm, wrist, and fingers was struck, and its feeling fixed in the association group (I, pp. 310–311).

The whole fourth month,—from the thirteenth week to the seventeenth,—may be assigned to this practice period, but it ran on several weeks beyond, into the period of visually guided grasping.

Almost all observers make some mention of a habit of carrying objects to the mouth at about this period; but I am not able to determine from their records the date of the beginning of the practice, nor its influence in the acquirement of true visually guided grasping (see pp. 99–100 and I, pp. 403–405).

Grasping with the Mouth by Neck Movements.—Meanwhile, as soon as the ability to lift the thumb toward the mouth had been fairly acquired, in the twelfth week, I had noticed a well-adapted downward movement of the head to aid the mouth in grasping it; so that in fact the thumb was quite as much seized by the mouth, by a neck movement, as it was raised and put into the mouth by an arm movement. After the baby had learned to put objects into her mouth, from the thirteenth week on to the twentieth, even after visually guided grasping had begun, mouth-grasping, with excellent co-operation of hand, mouth, and neck, continued conspicuous (I, pp. 309–317, passim; pp. 399–401, Tables III and IV; p. 404).

Probably this co-ordination was acquired by more gradual steps than I observed,[54]—perhaps through movements of the head at the breast; but it certainly suggests a great phylogenetic antiquity,[55] and may have developed so rapidly, along the lines of association deeply marked by inheritance, as to have seemed an almost perfectly transmitted instinct. Certainly there is

[54] Mrs. McLeish notes that as soon as her little girl had learned to direct the thumb to the mouth, the mouth was opened as soon as the thumb started upward. See also the observations on my nephew, note 56.

[55] Kipling somewhere mentions it as a well-known habit of infant monkeys to reach for objects with the mouth, before learning to use the hands.

no such visible process of learning by trial and error as there is in the case of carrying the hand to the mouth, and in that of carrying objects to the mouth with the hand,—both, of course, movements later in race history than seizing with the mouth by neck movements.

I have already called attention, in the pages cited just above, to the frequent mention of the mouth-grasp by other observers. I can not, however, determine from their records whether they saw it before the period of visually guided grasping: Tiedemann's note seems to imply that he did.[56]

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[56] *Op. cit.*, p. 21.

The organization of this co-operation between hand, arm, mouth, and neck in my nephew's case shows strikingly the gradual nature of the process. I give a condensed transcript of my record:

9th week: At the touch of nipple or his own hands, about the lips, the tongue is thrust forward, and the mouth twisted and stretched toward the object, but no real ability to seize with the mouth, only to lay hold when the object is fairly between the lips; 61st day, the head also is turned in such efforts.

On the 62d day, the head is moved toward the hands when they approach near the mouth, the mouth meanwhile opened expectantly; this without visual aid, evidently by association with the muscular feeling in the approach of the hands.

Automatic tendency of arms to flex upward is peculiarly strong in the boy, and hands are thus brought to mouth without effort to direct; throughout 10th week no advance in directing.

11th week: Hands are moved about with appearance of effort and desire, but no intelligent direction toward the mouth, till they chance to come into immediate mouth neighborhood (perhaps an inch or two distance); then they are slowly guided in, especially if the lips are touched. I suspect the appearance of effort and desire is due only to vague touch-hunger of the mouth, not definite idea.

12th week: Arms flexed more consistently upward in trying to reach mouth; when they come near it, more intelligently steered, while the head is dived forward to meet them.

15th week: Has begun to grasp objects upon contact, and pulls his blanket, etc., up with both hands before his face,—merely for pleasure in the action, it appears; no effort to put in his mouth.

16th week: When he lays hold of folds of drapery, our fingers, etc., he drags them about with undirected movements, but appearance of desire, especially up and down, with the habitual flexing of the arm, till they come within 3 or 4 inches of the mouth, then tries to carry them to it, or to reach them with the head,—once lifting shoulders in the effort, as he lay, to get the head far enough forward.

17th week: Gets his rattle to his mouth by a very primitive trial and error method, lifting and lowering it each time, till it chances to hit the right place. But visual guidance is now beginning, and purely tactile-motor associations checked in development.

4. PERCEPTIONS OF SURFACE.

It requires an effort to divest our own tactile-motor perceptions of visual representation far enough to get any glimpse of what the baby's must be at this stage. But in my niece's case it is certain that up to the middle of the fourth month they were not affected by sight. She never noticed her own hands as they moved about; never turned her eyes toward them nor toward any other part of her body upon feeling contact there, even when evidently interested in the experience; never looked at objects while touching or holding them (I, p. 312). And all records that I know are in practical agreement with mine as to this.[57] Even when the objects that she touched were the same ones that she had often seen, she seemed to feel no relation whatever between the visual and the tactile experience: she had, so to speak, no idea that what she touched was the same thing as what she saw.

Again, her tactile-motor perceptions themselves must have been almost wholly devoid of form-representations. For she had never felt over and about any object, acquainting herself with its extension,—and here too all records that I know are in practical agreement.[58] When she laid hold of anything, therefore, she could have had no idea—visual, tactile, or muscular—of its existence beyond the surface of immediate contact with it; no visual or tactile idea of her own hand, outside its areas of contact with the object and with itself; nor of the arm that raised it to her mouth. Only within the mouth-region, where the constant movements of the tongue must have made the inner surface of the mouth fairly familiar, and where one or two objects (the mother's nipple, at least, and the baby's own thumb) had

[57] A number of observers report interest in looking at the hands earlier than I do; but in every case it was plainly either such interest as might be shown in any visual experience (as if the hand had been some one else's, waved before the baby's eyes); or else it was an early stage in the fusion of visual and tactile perceptions, which in my niece's case began somewhat differently.

[58] The automatic movements of the hands about the face, always seen in vigorous new-born children, are sometimes mistaken by the observer for intentional explorations. But real hand investigation of objects before the epoch of visually guided grasping has never been recorded.

been daily grasped, held, sucked, drawn in and out, and felt over with the tongue, could any ideas of form have been obtained. I am not disposed to think that they were obtained, even here, for there had been no *attentive* investigation of the objects; the data may have been present for a perception of form, but it is not likely that they had been utilized.

Of surface, however, the baby must undoubtedly have had perceptions, when she passed her tongue attentively over her lips; when she licked some one's cheek; when her hand touched her own cheek and trailed over it to her mouth; when she groped with finger-tips across our dresses, or her tray; when she fumbled at an object to get a good hold. Considering the variety of experience yielded by smooth or rough, cool or warm, soft or hard surfaces, it is noteworthy that the interest shown in them was so slight,—barely enough to show that they were noticed, so far, at least, as the hand was concerned; and even the more delicate perceptions of the lips and tongue seem rather to have given mild pleasure than to have aroused the curiosity and effort to apperceive which seemed needed in the visual field for all steps of progress.[59]

5. EARLY TACTILE-MOTOR INTERPRETATIONS.

Direction and Position.—There must have been some data toward these interpretations in the baby's consciousness, in the period just preceding visually guided grasping; but they were certainly not sufficient for any real interpretation, at all generalized,—unless, perhaps, the constant relation of the parts of the mouth, as perceived both by tongue and fingers, had given something that might be called an idea of the position of the parts and their direction from each other. But I saw no sign in the first half year that these relations had attracted attention; it was at a later period that the mouth was intelligently explored, with an evident attempt to organize and comprehend the touch perceptions. Again, the constancy with which the finger-tips

[59] The same indifference to tactile experiences, as compared with visual, has been noticeable in my nephew. Mrs. Tilley's younger boy, who began licking objects a good deal about the 7th week, seemed in the 12th to be "investigating things" in this way. See also p. 96, note 60.

encountered the palm on closing, and the upward movement of the hands found the mouth, must at least have prepared the way for the feeling that these bodily parts occupied a definite place. Direction up and down in arm movements must have been marked by difference in gravity feelings; the movement toward the mouth by a sort of foreshine of mouth pleasures, which were lacking when the arm moved in any other direction; so, too, the movement across the tray to lay hold on a familiar object. But in all this there is rather the mechanical repetition of a familiar movement to obtain familiar sensations than any incipient inference of direction, such as led the baby in the thirteenth week to turn and look intelligently for a person who had gone out of her field of vision. Indeed, it would seem *a priori* an impossibility that a feeling of direction and position could be experienced before the feeling of a continuum of some sort in the external world had been reached; and this feeling, so quickly attained through the eye, could be reached through touch only after a large and varied accumulation of experiences. This accumulation once made, there is ample evidence (from cases of persons born blind) that tactile-motor perceptions may reach a high psychic value with no aid from sight, may be systematized into an excellent understanding of form, of direction, position, and distance, and give an even clearer sense of the objectivity of the external world than the eye can give.

Distance Estimate.—The adjustment of muscular action to distance had become accurate for two or three well-practiced movements,—the hand to the mouth, the mouth and hand to meet each other, at least; and the latter was a complex adaptation, swiftly and accurately made. Yet here is probably only a muscular adjustment of the same order as that of the eye muscles in fixation or in accommodation; adjustments directed by muscular sensation, it is true, but not developing into an *estimate* of distance in terms of muscular sensation, until attention had been bent on the changes produced in phenomena by them, and these changes had been reduced to some primitive mental order. Such an apperception of distance, like that of direction and position, required a much larger accumulation of

tactile-motor experience than the baby possessed as yet; and I think we are justified in concluding, not only *a priori,* but from the absence of attention and curiosity in her behavior, that the interpretation had not dawned.

Identity of Objects.—For this inference, too, some data existed. Consider, for instance, the sensations given by a rattle, which the baby often grasped and carried to her mouth,—a wooden shaft, with a sleigh bell on one end and a nipple on the other. At one time her finger-tips grazed the sleigh-bell, and a smooth, cool surface was perceived; at another she grasped the shaft, and felt the contact of the wood across a strip of palm and finger surface; she lifted it, and sensations of weight were added to those of contact; again, it was perceived by means of indefinite light thumps about the lips, then of more extensive pressure, moving across them; and, finally, as the complex feeling given by the nipple held and sucked in the mouth. Detached and unrelated as these different presentations of the rattle were, incapable of giving an idea of the rattle as a whole, it needed only that the baby should make an attentive tactile-motor investigation of the object,—turning it, balancing it, feeling it all over and about,—to bring them into continuity and associate them firmly into a group which (as actually happens in the case of the congenitally blind) should ultimately fuse into the perception of an object, one and identical.

But, as I have said, this attentive handling had not yet taken place, and did not take place till after visually guided grasping was established; I find no evidence whatever, in any record, of its appearance before that epoch. I can not see, therefore, how the rattle can have been as yet anything but a number of unrelated phenomena. I think we must conclude that in the case of seeing children, the hand does not learn to give any report of objects as such until its tardy interpretations have been anticipated by being caught up into one current with the more advanced visual ones. When the baby gropes across her tray for an object, grasps it without looking at it, and carries it to her mouth, it is hard not to imagine her state of consciousness just like our own, should we perform the same action with eyes

turned away. But a little consideration shows that this is impossible. She has no data from which to form an idea of an objective rattle to be sought,—it has not existed to her tactile consciousness except as certain contact and weight perceptions; nor of an objective hand to grasp it, nor arm to lift it, nor mouth to receive it,—these have existed only as recurrent perceptions of touch, and of the movement of her own muscles; and all these perceptions unlocalized in space. The transaction is only a series of tactile and muscular perceptions, strung together on a chain of association, so that each step in sensation is able to suggest the next step in movement,—with the help, no doubt, of ideas that arise, representing the coming pleasure of hand and mouth.

About the mouth alone it is possible that perceptions were more highly organized. The various sensations yielded by the mother's nipple, and by the baby's own thumb, when received into the mouth, must have come into firmly associated groups, which were recognized and represented as separate wholes before the middle of the fourth month. But it was by a sort of mechanical associative process, and I doubt if it involved any real step toward the interpretation of objective identity. There was no intelligent perception of the different touch aspects, so to speak, of thumb or nipple, no attentive effort to apperceive them as belonging together, such as that with which the baby wonderingly identifies the different visual aspects of an object (p. 74).

That remarkable visual advance, it is true, took place a little later than the date of which I have been speaking, and after the convergence of sight and touch upon objects had begun; but it was none the less a purely visual-motor one, unaffected by touch associations. As I said in relating it (p. 73), the synthesis of the two association series was gradual (sight and touch converging at first only upon a few, near objects, and even upon these most imperfectly, for several weeks), and during a period covering perhaps the fifteenth to the twentieth weeks, the visual-motor associations continued in a remarkable independent development, vividly interesting to the baby herself. I have

scrutinized my notes closely for indications of any similar independent advance in the tactile field during this transition period. I find none, unless the increased skill and promptness with which a few familiar objects were carried to the mouth indicated a sort of discrimination among them, a recognition of the special demands of each, which implied an advancing association between the different tactile presentations of each (I, pp. 313–316).[60]

6. SUMMARY AND TABLES.

The development of the active use of the touch-organs, then, was as follows:—

First: During the first three weeks of life, both hands and lips closed on objects by simple reflex movement. Spontaneous movements of the arms tended to bring the hands often to the sensitive tactile region of the mouth.

Second: In the 4th week rudimentary grasping with the lips appeared, perhaps by associative suggestion from experience of the breast in nursing.

Third: In the 7th week active touch was exercised by the tongue.

Fourth, Fifth, and Sixth: During the 9th to the 12th week, three parallel developments were taking place:—

Active touch in the fingers;

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[60] Mrs. Moore, Mrs. Beatty, and Mrs. Tilley record an advancing interest in active touch during the transition period; attentive hand investigation of surfaces (not of forms) thus beginning before the eye had really come to aid it. An interesting note by Mrs. McLeish shows that while visually guided grasping was still most uncertain (18th week) her baby could reach out with eyes closed for the nipple, located by tactile-motor memory, and grasp it with precision and promptness. In these cases there must have been a further advance toward the development of purely tactile-motor interpretations of form, distance, and direction, as well as more advanced perceptions of surface, than in my niece's case.

The brandishing of rattles and bells that is reported at this period, in my own notes and in others, the rustling and tearing of paper reported by Mrs. Hall, are also instances of the use of the hand to obtain sense-pleasure directly, instead of merely as servant to the mouth; but here the pleasure consists rather in the muscular and auditory sensations than in those of touch.

Grasping with the hand, directed by purely tactile-motor associations;

Carrying the hand voluntarily to the mouth, to suck the fingers and thumb.

Seventh: In the 12th week appeared a well-developed mouth-grasping, by movements of the head, directed by purely tactile-motor associations.

Eighth: In the 13th week objects began to be voluntarily carried to the mouth.

Ninth: A practice period followed, 13th to the 17th week (and beyond, running on into the period of visually directed grasping), in which the chain of tactile-motor association by which objects were groped for, grasped, carried to the mouth, and there felt over and sucked, was perfected.

Tenth: From the 7th week perceptions of surface were received, and by the fourth month they must have been fairly clear and somewhat varied for the tongue and lips, but most rudimentary for the hand.

Eleventh: Some fragmentary data toward interpretations of direction, position, distance, and objective identity existed by the end of the fourth month; but they were far more meager than those gathered in the visual field, and as they do not seem to have been attended to or apperceived, it is unlikely that such interpretations had begun to be made, even in the most rudimentary fashion, until they were aided by the eye.

We may see here essentially the same synthesis as that already traced in the visual field, if we keep in mind the mouth, not the hand, as the touch organ at this period. The movements of the hand and arm so far are to be classed with those of the neck, lips, and tongue, as directed merely to bringing the stimulus into contact with the surfaces of highest tactile sensibility, exactly as the movements of the eyeballs and lenses, and of the neck (and to a considerable extent even those of the trunk in straightening up the back), are directed to bringing the visual stimulus into contact with the most sensitive portion of the retina.

Thus we have to begin with, the *passive sensibility to touch*

in the lips and tongue, and the *automatic movements* by which stimulus is brought to these organs; then *association groups formed under direction of the feeling of enjoyment* between the tactile-motor sensations[61] that result from these movements and the muscular sensations that accompany them; until representation of touch pleasures to come (or even the mere craving of the organs for their proper stimulus) is able to suggest the voluntary repetition of the movements.

Supplementing this, we have a second association-group, formed in the same way between the tactile sensations of the hand and the movements of reaching and grasping, and linked to the first group through the association of the muscular sensations of the arm with both. But the hedonic quality of the hand perceptions is still so slight that this second group is psychically only an auxiliary of the first, devoted merely to increasing the variety of touch stimuli presented to the principal touch organ.

Thus touch has become an active sense, intelligently directed to the exploration of the objective world in search of sense-enjoyment, just as perfectly as sight; to a far more limited extent, it is true, but only because its ability to get at stimuli is so limited, while the child is unable to move about, and the ministry of the hand is still so imperfect. If vision did not come in at this point to direct the hand, the child would soon learn to grope and seek with diligence, and would obtain great variety of touch sensations; but so far there is but the least rudiment of seeking, and the sense satisfies itself with constant use of the one source of stimulus that lies always at the infant's command, —his own thumb and fingers,—and such meager supplementary objects as come to hands and mouth almost unsolicited.

[61] These are not wholly sensations of touch, since the group of sensations, tactile and muscular, involved in sucking seems to be the great source of enjoyment. This complicates the analysis of the touch-motor associations a little; for instead of having a series of hedonic touch sensations on the one side associated with a perfectly parallel series of neutral muscular sensations on the other, we have on the hedonic side both tactile and muscular sensations to be associated with the parallel series of neutral muscular sensations, on what may be called the utilitarian side of the association.

A comparative tabulation of the reports of different observers on the stages by which the use of the touch-organs is attained, presents great difficulties. Variations in the order of overlapping among the developments of hand, arm, mouth, and neck, do not affect the real similarity in essentials which the records show; yet they obscure it greatly in a chronological table. Again, most stages of the development are gradual, covering several weeks, and it is often impossible to tell whether a note refers to an early or a late phase of the process. Nevertheless, for the sake of gathering together the available data on the subject for reference, I gave a tabulation (IX(*a*)) in which my own results are compared with those of the other fairly consecutive records, and annotated with the fragmentary items I find elsewhere.[62] From this somewhat confused table and accompanying notes, by setting aside the most precocious and most tardy instances, we may sift out the points of substantial agreement presented in Table IX(*b*):—

All records agree as to the absence of marked interest in hand sensations; as to the centering of the whole series of associated movements upon the tactile-motor sensations of the *mouth*, the high degree of comfort afforded by these, and the persistence with which they are sought; yet the absence of signs of lively pleasure or intense attention excited by them is noticeable.

During this whole period the baby had, of course, frequent experience of concurrent tactile and muscular sensations in other parts of her body, besides the hand and mouth region; but neither by signs of attention nor by the attainment of con-

[62] See also I, pp. 399–405, Tables III–VI. The record in my nephew's case is continuous, but made too late to incorporate into the table. I append it here:

8th week: Grasping with mouth, on touch suggestion.
10th week: Active touch with tongue and lips.
11th week: Active touch with fingers.
Directing hand to mouth.
12th week: Longer and more attentive holding.
Reaching with head and neck to grasp.
13th week: Grasping with hand on chance contact.
15th week: Intelligent tactile-motor grasping with hand.
16th week: Beginning of carrying objects to the mouth at will.

trol over her movements did she show that association groups were formed among these sensations,—except as tactile sensations entered somewhat into the group by which the nursing

TABLE IX(*a*).

DEVELOPMENT OF ACTIVE TOUCH AND TACTILE-MOTOR GRASPING.

Age of Infant.	Stages of Development, Observed by			
	Shinn.	Tilley.	Hall.	Moore.
1st 3 weeks.	Passive sensibility to touch. Reflex closing of mouth and hands on objects placed in them. Spontaneous arm movements, tending to bring the hands near the mouth.			Getting hold of nipple with mouth, 4th day[64] (girl), 3d week (boy).
4th week.	Grasping with mouth (upon touch suggestion?).			
6th week.		[2d boy.] Longer and more attentive holding; clasping movements repeated.		Longer and more attentive holding.
7th week.	Active touch with tongue.[62]			Grasping with hand on chance contact.
8th week.		Active touch with fingers (?)	Directing hand (thumb) to mouth, 1st efforts.	
9th week.	Longer and more attentive holding;[65] fingertips held together.		Longer and more attentive holding.	Reaching with head and neck to grasp.
10th week.	Directing hand to mouth.[66] Grasping with hand on chance contact.[67]			Active touch with fingers.[68] Directing hand (thumb) to mouth (both children). Intelligent tactile-motor grasping with hand.
11th week.		Grasping with hand on chance contact.		
12th week.	Active touch with fingers.[69] Hand (thumb) skillfully directed to mouth. Intelligent tactile-motor grasping with hand.[70] Reaching with head and neck to grasp.		Objects carried to the mouth.	
13th week.	Beginning of carrying objects to the mouth at will.[71]	(1st boy.) Active touch with fingers. Putting things in mouth. Directing hands to mouth	Intelligent tactile-motor grasping (?) (*Op. cit.*, p. 396.)	
14th week.	Persistent practice in feeling for objects, carrying to mouth, and there investigating by active touch, as well as sucking.	Intelligent tactile-motor grasping with hand, both children (2d child possibly as early as 11th week).		

position was recognized (p. 54), and the groups experienced in sitting up (I, pp. 326-329), and in kicking for pleasure (I, pp. 188-189). But as neither of these association groups played an important part in that synthesis of sense experience by which the outer world became known, I need not dwell upon them here.

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[63] This seems to have been seen early by Mrs. Moore, but she has not given the date.

[64] Preyer mentions the same act as usual a few days after birth, but cites no direct observation. It can not, of course, be regarded as anything but a reflex at this age.

[65] Mrs. Saunders (MS. notes) records this in the 5th week; Prof. Preyer not till the 14th week—no doubt in the one case an incipient phase of development, in the other an advanced one.

[66] Mrs. McLeish's little girl learned from the 7th to the 10th week to carry the thumb directly to the mouth; Mrs. Saunders reports the movement well learned by the 14th week. Sigismund saw the fingers carried to the mouth "toward the end of the first quarter-year."

[67] Mrs. Moore reports grasping on chance contact, in the case of her girl, on the 14th day, but this can scarcely have been anything more than the primitive reflex. Mrs. Emily Fogg Meade, in a letter, mentions a grasping that seems to be of the more advanced, but still largely mechanical type (p. 82) in the 9th week; Mrs. McLeish records in the 10th week grasping that may be of this type, but has some traits of intelligent action (*op. cit.*, p. 118); Preyer saw what he regarded as intelligent grasping upon chance contact in the 12th to 14th week.

[68] Dated 10th week, *op. cit.*, p. 16, and 11th week, p. 74.

[69] Seen by Mrs. Daniel also in the 12th week.

[70] The grasping seen by Sully in the 11th week should probably be classed here (*op. cit.*, p. 13); so also, perhaps, that noted by Mrs. Beatty in the 16th week.

[71] Darwin notes carrying objects to the mouth 12th or 13th week; Tiedemann about the same date; Sigismund, "toward the end of the first quarter-year"; Mrs. St. John in the 12th week; Mrs. Conard in the 13th; Mrs. Wood at 3 months old for one boy, at 4½ months old for the other; Mrs. Beatty in the 15th week; Mrs. McLeish in the 17th week. All these notes seem to refer to voluntary conveyance of articles to the mouth, for the sake of the sensations, not to the early accidental lifting thither of articles that chance to be in the hands. Mrs. Moore notes precocious isolated instances of what looked like voluntary effort to carry something to the mouth, as early as the 4th week (girl), and 5th week (boy); and I noted one in the 7th week (p. 86, note).

TABLE IX(*b*). TABLE IX(*a*) CONDENSED AND GENERALIZED.

AGE OF CHILD.	TACTILE-MOTOR DEVELOPMENT.
First six weeks.....	New-born condition of passive sensibility and automatic movement.
	Toward the end of the first month, grasping with the mouth, by associative suggestion.[12]
Sixth to ninth week.....	Active touch with the tongue well developed; no doubt incipient earlier.
	Incipient signs of active touch and grasping with hands.
Eighth to thirteenth week.	Active touch with fingers well developed, but not important for direct sense pleasure till later.
	Directing hand to mouth, and presenting thumb to insert, acquired by practice.
	Grasping on chance contact, quite mechanically, but apparently by associative suggestion, not pure reflex.
	These three developments vary considerably in order of appearance, having no genetic relation to each other, though they co-operate.
Tenth to fourteenth week.	Objects laid hold on with some degree of intelligent adaptation, and soon even felt for and reached after, without visual aid.
	Advanced and skilful reaching with head and neck to grasp, co-operating with hand and arm, under guidance of purely tactile-motor associations.[12]
Thirteenth week on.....	Objects carried voluntarily to the mouth.

III. SYNTHESIS OF THE VISUAL-MOTOR AND TACTILE-MOTOR ASSOCIATIONS.

The manner in which the visual and tactile perceptions coalesce, and the object of sight is identified with the object of touch, seems quite clear. All observations agree in indicating that it is in watching the hand, or the object held in the hand, that the identification is made. There must, of course, be other ways to the same end, for no one can doubt that a handless child would sooner or later make the identification; the handless animals make it readily. I venture to think that even in the case of the normal human child some beginning has been made in recognizing the object of vision as the object of mouth-touch before it is recognized as the object of hand-touch. But the remarkable fitness of the hand to afford simultaneous

[12] Comparative observations lacking, yet the stage is probably common and normal.

and parallel experiences of an object to sight and to touch, brings it quickly to the front in the psychological process, and carries this process to an extent that can hardly be possible without hand investigation. Mouth investigation can only associate the object seen with the object felt by *successive* experiences of it, a very different thing from simultaneous ones. One may question whether a hoofed quadruped, unable to feel an object while looking at it, and to see himself feeling it over, does ever actually reach a perception of objects as such, like ours.

1. INCIPIENT ASSOCIATIONS OF THE OBJECT SEEN WITH THE OBJECT TOUCHED.

When the infant recognizes a face (usually in the third month, see Table VII, p. 68), some association has certainly taken place between the visual appearance of the person recognized and the other experiences that have been received from him. There is here no definite association of the sight of an object with the "feel" of it, but only with a complex of experiences, among which tactile ones are included,—or, perhaps, not even with that, but only with a revived hedonic feeling.

The sight recognition of the nursing bottle, breast, spoon, or cup, about a fortnight later (p. 68, note), is a decided advance toward identifying the object felt with the object seen. We certainly have here a case in which the visual experience is able to suggest experiences in other departments of sense quite definitely,—experiences of taste and of the satisfaction of hunger, mainly, but also tactile experiences. This recognition is reported by a few observers as clearly prior to the convergence of visual and tactile attention on the hand;[73] but in the majority of cases, as in that of my niece, it was later.

[73] *Op. cit.*, Sully, p. 405 (10th week); Mrs. Hall, p. 524 (13th week); Mrs. Moore, p. 47 (12th week); Mrs. Tilley, MS. notes (12th week). Yet a remarkable note of Mrs. Hall's (*op. cit.*, p. 394) shows how feeble the association was, nearly a month later: "In the 16th week, when held close to the breast, he often slipped his thumb into his mouth under the impression that he had the breast, but became impatient when he found that it yielded nothing. In the 17th week the breast was shown him while he still held his thumb in his mouth, and then for the first time he seemed to realize that the two were separate and that he must release his thumb before

2. WATCHING THE HAND MOVEMENTS.

Soon after the mastery of the full mechanism of vision, and of some voluntary use of the hand, while attentive visual exploration is going on, the hand and its movements naturally fall under observation, along with other objects. The correspondence between the feelings of movement in the hand and the changes in the visual image seems to arouse the child's attention, and to establish quickly an associative connection, by means of which the movements of the hand are voluntarily practiced for the benefit of the eye. Here the association is mainly between visual and muscular perceptions, but the touch of the hand upon itself or against neighboring surfaces must be more or less perceived as it is watched.

This stage did not occur in my niece's case. It is mentioned by so many mothers that I watched for it carefully, and in vain. But it is abundantly recorded by others,[74] and falls

obtaining the breast. Up to this time the thumb had been removed for him, but on this occasion no assistance was given until he himself had made an effort to remove it and had failed. He looked at the breast, then worked at the thumb, then cried, but could not take it from his mouth. He was thereupon assisted and given the breast. Each time he nursed he was required to make an effort to remove the thumb, and was afterward given such help as was necessary. Late the next day, after a long trial and some crying, he succeeded in his efforts, whereupon he made a little sound of satisfaction and seized the breast. Six days later he was able to remove the thumb at will and with ease."

[74] Mrs. Tilley records of her older boy, in the 14th week (at which date he already felt for and grasped objects) "Spends a good deal of time looking at his hands, turning them over wonderingly." The note "wonderingly" shows that attention was awakened, and an effort to apperceive the sense phenomena was taking place. Three weeks later this boy was grasping at objects seen. Of her second boy, Mrs. Tilley records at 12 weeks, "Has looked at his hands." At 3 months: "Has gazed at his little hands a good deal. Sometimes lately when he has hit something with his hand, he will look first at one, then at the other, sort of puzzled, and I have fancied that he tried to see if he could do it again. At any rate, he looked in wonder at his hands when he hit the chair or paper." Four weeks later, the child was grasping by visual guidance.

Sully's boy in the 9th week "was surprised in the act of surveying his own hands." This early survey seems to lead to no association—the hands are looked at as any other object would be. But when the boy was a little over 4 months old, and already able to grasp an object felt for, "He would now bring his two hands together just above the level of

always at the same period, just after the full mastery of vision and of some voluntary use of the hand, and just before the beginning of true visually guided grasping, usually in the fourth month.

3. LOOKING AT THE OBJECT HELD IN THE HAND.

It is evidently in looking at an object while touching it with the hand, and in giving attention to both presentations of the object, the visual and the tactile, that the identification of the two worlds of sight and touch is most easily reached. In the fifteenth week my niece began to look at her hands in the act of

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his eyes and then gaze on them attentively, striking out one arm straight in front of him, and upward almost vertically, as if he were trying some new gymnastic exercises, while he accompanied each movement with his eye, and showed the deepest interest in what he was doing. By such exercises we may suppose he was exploring space with hand and eye conjointly and noticing the correspondences between looking in a given direction and bringing his hand into the line of sight." Within the next month the boy began to make efforts to grasp an object seen (*op. cit.*, p. 413).

Mrs. McLeish's daughter, on the 88th day, "noticed her hand for the first time. She lay for 30 minutes looking at the right hand, twisting and turning it. The next day she made her first effort to grasp, using the right hand. [Real grasping at sight was not attained, however, for more than a month after that.] Four days later she first looked at her left hand. After playing with it for some time, she brought her two hands together with much effort, the fingers just touching. For several weeks after that she played with her hands a great deal." (*Op. cit.*, p. 111.) These weeks of playing with the hands were just the ones in which grasping at objects seen was slowly learned.

Mrs. Saunders's boy, in the 15th and 16th weeks, "would seem interested for minutes at a time holding his hands up in front of him as he lay, and slowly turning them over and over, and scrutinizing them most carefully." Soon after this he began to grasp; I can not quite fix the date from the note. Mrs. Cook's boy at 4 months "notices the moving of his own hands, and has been seen to watch them intently while he slowly moves his fingers." Apparently this boy was grasping at 5 months old, though the note is not quite clear. Mrs. Daniel's daughter in the 10th week examined her hands carefully, and at 4 months reached intelligently for what she wanted. So, too, Mrs. Daniel's other children, E. Schulte's child, mentioned by Preyer (*op. cit.*, p. 47), Mrs. St. John's, and Mrs. Moore's children, all surveyed their hands noticeably, some time between the 3d and 4th months. Mrs. Catterall's boy, in the 12th week, looked persistently at his fingers *cross-eyed*, but this must have been a purely visual experiment, to see the fingers doubled by focusing too short.

grasping, and at the objects in them; her manner was blank and uncomprehending as she did so, and yet the touch of an object against her hand did seem to suggest turning her eyes toward it, as well as laying hold of it with her hand (I, pp. 312, 313). This began just a fortnight before the first effort to lay hold of an object seen. In the early stages of visually guided grasping, when the association between the object visible and the object tangible was still feeble, watching it while laid hold of continued to be a great aid in identification.

There is no lack of confirmation from other records[75] as to the disposition at this stage (just before grasping the seen object, or in the earliest uncertain grasping) to watch the process, or to bring into visual range an object already laid hold of without visual help. In this latter case the tactile perception has become able to suggest a movement that will produce a visual one; in the case of grasping at the object seen, the visual perception has become able to suggest a movement that will produce a tactile one.

[75] Mrs. Tilley's younger boy (who at 3 months gazed wonderingly at his hands when they struck against chair or paper, and looked from hand to object), in the 16th week would look at his rattle "critically" as he held it, and would pull up his blanket and look at it; in the 17th he scratched at a pillow beside him, and watched his fingers while they scratched, and clasped his hands together, and felt of one and then the other, as if it were a new feeling; in the 18th he laid hold by feeling of various objects near him, and watched both hand and object. This was upon the very eve of visually guided grasping, which began in the same week. Mrs. Moore's boy as early as the 10th week, Mrs. Daniel's in the 12th (both these were precocious children), and Mrs. Catterall's at 14 weeks, would lay hold of their dresses and bring them up to be looked at. Mrs. Hall's boy in the 10th week, when his hand was tapped with a pair of scissors, watched both the hand and the approaching scissors; but this seems to have been too early to fix any real association between the object seen and the object felt. Later he seems to have obtained a sort of preliminary practice for grasping by learning to pull a handkerchief from over his eyes, to pull his long dress over his face and off again, etc. Mrs. Moore's boy at 3 months watched his own grasping, and at 4 months took pleasure in feeling of everything in reach. My nephew began at 3 months to watch his hand and the object in it, while trying to get it into his mouth, though so short a focus was evidently hard for his eyes; in the 15th week, he would pull up blanket or dress with both hands and look at it; and in the same week began to make efforts to touch, or grasp, at sight of objects.

4. MOVING THE HAND TOWARD THE OBJECT SEEN.

There seems to be a good deal of evidence of a stage in which the disposition to grasp is no more than an aimless movement of the hand toward the visual stimulus. Certainly in the earliest grasping there is no such thing as a conception of an *object*, visual and tangible, with real purpose to lay hold upon it. My niece, at sixteen weeks old, made fumbling movements of the hand toward objects, looking at them, or struck toward them with the open fingers, till she touched them; it was only then that the vague and mechanical manner disappeared, and she took hold with intention. Apparently she repeated the sort of movement by which she had been accustomed to grope for and obtain contact with objects, but she did it now (after a fortnight of looking at objects while laying hold of them), *upon visual suggestion.*

This new initiation of the grasping action by visual suggestion seems to come by a natural process of association from the habit of looking at the object while grasping, and it is probably stimulated by representation of touch pleasures. But as to the ability to give the hand its *direction* toward the object we may have to credit something to an inherited and automatic adjustment. In the acquirement of the so-called "instinctive movements," individual experience and inherited tendency act and react quite intricately. In the first indefinite movement of the hands toward the object seen, there may perhaps be something of the primitive tendency to automatic movement toward the source of stimulus (p. 37). But by a perfectly traceable process this visually stimulated movement becomes associated with the voluntary gropings of tactile-motor grasping, so that the visual stimulus that discharges the one is able to suggest the other. With this, a gap is leaped; the eye can take the guidance of the hand, and a process of practice begins again, in which the mere impulse of the hand toward the object seen develops into real reaching for it and grasping it.

Some such combination of practice and instinct seems to me indicated by the records of others as well as by my own. "*Trying* to grasp" is repeatedly mentioned at the very outset of

visually suggested grasping. In the note below[76] I cite several

[76] "1st day of 5th month.—This morning we noticed the first reaching to grasp something. I held out the rattle; up came the little hand, but he began to open his fingers at the same time, and then stretch out the arm. He did not find the rattle, but he was looking at it and trying to." MS. of Mrs. Tilley.

"[On the 89th day] the green ball was hung from the top of her basket. . . . She lay looking at it for several minutes, then slowly and steadily her right hand was raised toward it with fingers extended. I lowered the ball, and again, after an aimless play of from five to ten minutes, the hand was raised as before. The right hand only was extended, and each time it was raised first to the mouth and then put out slowly and steadily toward the ball, with the fingers extended ready to grasp. It seemed as though the baby's first instinct, when she became conscious of her hand, was to bring it to her mouth, as in thumb-sucking. . . . [94th day.] This morning a great effort was made to grasp the ball. The whole body quivered with excitement, the tongue was frequently extended, lapping the lips. The ball was several times hit, but not grasped. Her reach was still a little short, and even when her hand was beside the ball her fingers did not close over it. On the 116th day there was still not much progress made in grasping. I held an ivory ring with silver balls in front of her, within easy reach of her hand. She tried to grasp it, but could not put her hand from her sufficiently. When she is eager to seize something, her hand seems to be involuntarily drawn toward her. In this instance she brought her hand first to her mouth, as in grasping for the ball, and then reached it out toward the ring, but unsuccessfully. When I put the ring into her hand she seized it, and carried it at once to her mouth." Mrs. McLeish, *op. cit.*, pp. 118, 119. This is not the manner of action that takes place when a real association has been established between the feel of the proper movement and that of the desired sensation, and the movement, imperfectly made, needs only to be perfected by practice. It is just the sort of action we should expect, if the sight of the eye has become able to suggest touch desire, and to initiate an unintelligent out-thrust of the hand toward the stimulus. Four days after this ineffective effort at visually guided grasping, the little girl, losing the breast from her mouth, reached out her hand, seized it, and put it into her mouth, without opening her eyes; "there was not the slightest hesitancy either in grasping it or in bringing it to the mouth." This was tactile-motor grasping; and a few days later, after being practiced a little in recovering the nipple of her bottle (removed from the mouth) by tactile-motor grasping, she repeated the same act correctly at *sight* of the bottle—obtaining thus, by repetition on visual suggestion of an act already familiar on tactile suggestion, the missing link in association; and in a fortnight more she began really to grasp under visual guidance.

"The brass knob on the bed was the first thing reached for. Date not given. The first time he was held near it, he fixed his eyes on it, became excited, making movements with the whole body, not in the direction of

passages that seem to indicate no real effort to get hold of an object, but rather mere movement toward it, stimulated by memory of touch-pleasure, suggested by a sight which has become associated with that memory, but *not* guided by any acquired idea of the act to be performed. That is, the muscular

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the knob, but vague wrigglings, the eyes remaining steady. This was repeated at three different times on the same day. The third time, he waved his arms from the shoulder. The next day, the body movements and waving of the arms were repeated; this time slightly toward the knob, but he did not touch it (one trial). The third day, after this preliminary exercise, he suddenly plunged the left hand forward, and laid it directly on the knob. In the previous efforts the hands had moved together, or nearly so. This play was repeated daily, often several times a day. After his first success he grasped it readily, at the first effort. No assistance was ever given him beyond holding him steady at reaching distance.'' MS. of Mrs. Cooley.

''The next noticeable advance took place at the end of the 19th week. The boy's father held a biscuit (the value of which was already known) just below his face, and well within his reach. There was a very earnest look and then a series of rapid, jerky movements of the hands. These were uncertain at first, but on repetition of the experiment grew more precise. At first the biscuit was dropped. . . . But after repeated trials he managed to hold on to the treasure and bear it triumphantly to his mouth. The discovery of the new delight of feeding himself led to more violent efforts to seize the biscuit when presented again.'' (Sully, *op. cit.*, p. 414.) It was not till the boy was six months old that this incipient grasping developed into good grasping, ''involving a perception of distance.''

''9th week.—Incipient reaching was observed, the hands moving toward the object upon which the eyes were fixed.'' Mrs. Moore, Comparative Observations of Movements, p. 4. This seems to indicate (as in so many of Mrs. Moore's notes) some very early and automatic form of the movement, for it was not till the 18th week that this child (a daughter) is noted as having fairly acquired the reaching habit and adjustments. In her record of her son, Mrs. Moore speaks of the trembling, uncertain movement in the first grasping, and mentions that in the 17th week the object was sometimes struck by the back of the hand, and the child was then able to turn the hand and grasp—just as my niece seemed only to know what she was going to do when the hand had touched the object, and tactile association came into play.

''109th day.—When a vase containing a single yellow flower was placed on the table before him, he became much excited, making motions with both hands toward the flower. The motions were illy directed to be sure, but he nevertheless succeeded in obtaining a hold upon the vase with the right hand, and in maintaining it until he had worked the hand up and procured the flower.'' Mrs. Hall, *op. cit.*, p. 396. Apparently the child merely moved both hands toward the object, till one touched, and tactile-

sensations of the proper movement have not come into the association group through practice, and the action is not intelligently directed. Yet some of the notes give evidence enough that attention and mental effort were involved.

In my niece's case five days of getting hold of objects "by a kind of vague clawing at them," looking at them the while, seems to have brought the movement sensations necessary to the direction of the arm into association with the visual and touch sensations, and the reaching out and grasping began to be intelligently performed by the 118th day,—began to be, but for a fortnight more, up to the end of the nineteenth week, the manner of grasping was doubtful; it was still to a great extent *feeling for* the object, without much dependence on visual direction (I, p. 315).

During this time grasping with the mouth upon visual suggestion was much more prompt and confident.[76a] This began with finding the nipple by sight, the repetition of a movement often

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motor grasping came to his aid. It was not till the 126th day that he grasped unmistakably, directing his hand.

Mrs. Beatty's boy in the 17th week "seemed trying" to get hold of something, and did not clearly reach for objects until the 18th week.

I note of my nephew, in the 15th and 16th weeks: "The sight of a hand, moving about in his easiest range of arm movement, seems to stimulate a vague motor disposition in his hands,—they move in a pawing sort of way, while he looks at the object, but there is no visual guidance; if they chance to touch the object conveniently, it is laid hold of." The whole process was always watched carefully by the child. In the 17th week, I thought that his manner in this pawing toward an object indicated some real desire to get at it, and that it was determined partly by mere overflow of excitement into the familiar flexions and extensions of the arm muscles, and partly by memory of former successful movements, which had been at once watched and felt. I thought also that I detected some element of effort to reach the object by a rough trial and error method, for the movement was varied till the object was struck. There was no ability to direct the hand by the eye. From the latter part of this week, he began visibly to select somewhat the successful movements, to widen the range within which he could get at the object, and to acquire some sense of relation between visual and motor direction; but up to the 20th week, his grasping was wholly empiric, so to speak, stimulated by sight, but only imperfectly guided by it, and largely dependent on tactile-motor memory.

[76a] So, too, in my nephew's case.

practiced, but heretofore without visual suggestion (I, pp. 315, 316); but this is not sufficient to account for the confidence and skill with which the baby dived for an object and got her mouth to it,—the element of instinctive, inherited adjustment must certainly be greater here than in the case of hand grasping. We should expect as much from the greater phylogenetic antiquity of mouth-grasping.

5. VISUALLY DIRECTED GRASPING.

As I have said just above, it was late in the seventeenth week that my niece first reached intelligently for an object and grasped under visual guidance. She was nearly nineteen weeks old before the movement took place with promptness and precision and it was not till the twentieth week that it ceased to be much aided by tactile-motor familiarity with the object and its position (I, pp. 316, 317. See also observation on my nephew's grasping, end of note 76, p. 110).

The period of free and skillful grasping is reached at about this time by every infant. In every case where detailed records are given (with one exception about to be mentioned) it has plainly been reached by a gradual synthesis of visual and tactile experience into a firm association group. The one exception is the very important one of Professor Preyer's record. This distinguished observer does not recognize any period of tactile-motor grasping, of carrying objects to the mouth, of mouth-grasping, of visual inspection of the hand or objects in it, before the time of visually guided grasping; on a first reading, one would conclude he had seen nothing but reflex clasping until the day when reaching for an object visually located suddenly appeared. Yet re-reading his account carefully, I see nothing in actual conflict with my own and the others I have cited. There was evidently some sort of "apparent grasping" after the fourteenth week, not visually guided, but not like the early automatic clasping; there was evidently in the first "efforts to seize" little more than a vague movement of the hand toward the object seen; and as for visual inspection of an object at the same moment that it was felt by the hand, it is possible that this did

take place, and would have been seen by a woman observer, occupied much of the day about the baby, holding and dressing and tending him. It seems evident from Professor Preyer's record that the baby was not supplied with convenient objects, laid or hung within reach, before grasping had been acquired; and where this is not done, the little hands, in the incipient stages of grasping, can only lay hold of folds of garments or the fingers of the attendants,—acts not so noticeable as the handling of toys.[77]

The development of skill in grasping need not be followed here (see I, pp. 317–324). There is but one more stage of the movement to be mentioned as significant in the development of sense perceptions.

6. JOINT TACTILE AND VISUAL INVESTIGATION.

Up to the twentieth week, grasping was exercised only for the purpose of supplying touch-pleasure to the mouth. So far, the new ability to unite the use of hand and eye had merely added one more link to the long chain of associations by which a sensation received from a distant source could be transferred to the sensitive region of lips and tongue; even visual perceptions could now be transmuted into mouth-pleasure. I do not think we are justified in supposing that the baby's consciousness at this stage included any perception of an object as one thing, to be both seen and felt,—she simply followed a chain of successive suggestions and associations from perception to movement, from movement to perception.

[77] Mrs. Tilley records of her younger son, in the 23d week, a week after free and good grasping was acquired, "Seems a good deal older than he did a week ago. Has been a week of great advance in reaching out, and in expressing his wants." Her note goes on to describe the increased gayety, interest in sounds, appealing for attention, etc., and adds: "His whole attitude just now is—wondering eyes—'I see it!'—little hands outstretched—'I want it.'" In a later note she records that from the time grasping was acquired, the baby's general bodily movement became firm—he would bend his body, *e. g.*, to reach far off for things, "and seems to have a good idea of where they are." This swift advancement in the location of self and external objects in space, these indications of a newly clear space feeling, correspond well to my observation.

But in the twentieth week the effort to identify objects visually had been for some time going on (p. 74); on the 132d day, late in the nineteenth week, had occurred the striking incident of the baby's wonder-struck effort to unify in her mind the different aspects of a well-known head and face (p. 74); and on the same day, bending backward and touching the floor with the back of her head, she showed an even ludicrous wonder at the touch, making persistent efforts to see what touched her,—a plain sign that she had come to expect a visual image as connected with a touch. On the 133d day she sought with her eyes to find a visual image *along the line* of the direction in which it had disappeared a few seconds before (I, p. 23). An immense psychic unfolding was going on, the visual interpretations of direction, position, and objective identity were plainly developing, the junction between sight and touch had been made, and it was inevitable that her attention and curiosity, her effort to apperceive phenomena, should presently turn to the objects held in her hand, and the variety of perceptions they were capable of yielding. On the 134th day she held a rattle up before her and scrutinized it carefully,—and with that began a period of grasping for objects in all directions, not merely to carry to the mouth (though that also was done), but to investigate. It was not that touch pleasure in the hand had taken the place of touch pleasure in the mouth, as a thing sought for its own sake (it never really did this; the mouth was always the sensitive region for purely æsthetic touch purposes, and doubtless remains so in adult life[78]); it was the free movement to and fro of the object under her hand, the variety of visual aspects presented by it as she watched, all answering in regular order to the touch and muscular sensations, that gave her such an interesting enlargement of experience, so grouped together as to be apperceived without confusion.

It is impossible to overrate the importance of this epoch. In my niece's case, it was connected with a swift and most eager and joyous expansion of psychic development in all directions. Stimulated by the ability to reach for and grasp her own feet, to

[78] Groos, Die Spiele der Menschen, p. 13.

look for the visual source of touches, to trace direction, her acquaintance with her own body grew rapidly, and the difference between it and the environing objects, which did not yield double sensations of touch, must have begun to define itself to her with new clearness. Her desire to reach objects led not only to bending and turning, but to the first scrambling attempt at locomotion, later to develop into rolling and creeping. The persons most intimately about her had plainly become not only unified phenomena, but well associated with hedonic experience and with mental stimulus, for she turned and looked unmistakably into their faces "for sympathy" in surprise or pleasure. Such a discovery as the tangible qualities of the object visible, the visible qualities of the object tangible, such an extensive opening up of cerebral connections as that by which the visual-motor tract and the tactile-motor tract come into intelligent co-operation, must bring with it into function a great number of other inter-connections; association paths ancestrally ready open up, almost in a day, at the pressure of new tensions, and the child becomes a creature of a new and advanced order of psychic being,—all this easily within a week, it may be, and was, in my niece's case.

The period of investigating objects by eye and hand jointly runs on indefinitely in the case of every infant,—for that matter, it never ceases throughout life. "Vision and manipulation," says John Fiske, "these in their countless indirect and transfigured forms are the two co-operating factors in all intellectual progress." The reaching for, seizing, and investigating all objects in sight constituted the chief interest of life for my niece up to about the eighth month, when locomotion overshadowed it more or less. It is throughout this period of practice, running on into the second year, or even beyond, that the visual and tactile and muscular interpretations correct each other, the perceptions fuse, visual direction and direction in terms of muscular sensation come to seem objectively the same thing, solidity becomes a visual perception, and the whole feeling of space, direction, distance, depth, becomes what we ourselves experience.

It would be superfluous to cite notes from other records to corroborate my own concerning this period of reaching and investigation, for the period is conspicuous and well known in every nursery, always following immediately upon the attainment of ability to grasp by visual guidance, and preceding the period in which locomotion becomes an important interest. A few citations illustrating special traits of the period I have given already in footnotes, and a comparative table of the chronology of grasping is given below.

7. SUMMARY AND TABLES.

The organization, then, of the visual-motor and tactile-motor association groups into a single group by means of which complex perceptions of the external world in three different sensory aspects were formed, took place by the following steps:—

First: The recognition of a face (in other cases, of the breast, etc.), occurring some time in the third month, showed that a visual image had become able to suggest associated experiences in other departments of sense, among which the tactile and muscular were included.

Second: In the 15th week, through observation of the hands while in the act of grasping, visual and tactile-motor images of the same object were constantly presented at the same time. (In other cases the empty hands themselves were watched, and even moved about, for variety in the visual and tactile-motor presentations.)

Third: Through this practice, a visual image came, by the end of the 16th week, to suggest tactile-motor images (perhaps of hand contact only, perhaps of the mouth pleasures which were the goal of the whole sequence); arm and hand movements were discharged by this suggestion, and directed imperfectly toward the object,—partly, it may be, in consequence of some idea of directing the movement, obtained from watching the hand in tactile-motor grasping, but partly by an inherited and instinctive adaptation.

Fourth: Before the end of the 17th week the sensations of these seeking movements, through success, became definitely asso-

ciated with obtaining the object, and the movements were repeated with intention, yet were still mainly of a groping character. The different sense experiences of an object seem not yet to have coalesced into the feeling that it was one, and the baby in reaching and grasping merely followed along a chain of suggestion, from the sight of the object to the mouth sensations,—the link between the visual image and the first hand touch being feeble.

Fifth: At the same time, the visual image was able to suggest grasping with the *mouth,* by means of head and even body movements, more decidedly and correctly than hand grasping, and this association had probably existed earlier than that between visual image and hand grasping.

Sixth: Meanwhile, from the 12th week on, an active visual study of objects had been proceeding, and by the 19th week some progress had been made toward visual identification of them as individuals. With the beginning of the 20th week, apperceptive attention was bent upon an object held in the hand; the visual and tactile perceptions seem to have come promptly into a firm coalescence, the associative link between a visual image and the touch sensations obtainable from it was strengthened, the expectation of tangibility in visual objects was generalized, and all objects were grasped for freely and confidently, instead of an occasional one doubtfully.

Seventh: From this time, objects began to be grasped not merely for mouth pleasure, but increasingly for the complex interest of investigation by sight, touch, and muscular sense; a period of many months set in, in which the outer world was explored by eye, hand, and mouth, and all our adult perceptions of objects and space must have been slowly formed, visual and tactile-motor direction coming to be felt identical, objects to be seen as solid, and the whole external world organized as we see it.

I can not find much comparative material suitable for tabulation concerning these stages, although (as the notes above show) a number of records describe one or another stage quite fully. Many records give a date for "grasping," but I can

not tell whether it means feeling for and getting hold of objects, without visual suggestion; feeling for them on visual suggestion, but without visual direction; or good visually guided grasping. Such material as I have is collated below:—

TABLE X(*a*). DEVELOPMENT OF VISUALLY GUIDED GRASPING.[79]

Age of Infant.	Stages of Development, Observed by			
	Shinn.	Tilley, 2d Child.	Sully.	McLeish.
13th week.		Watching own hand movements.[80]		Watching own hand movements.
14th week.				Hands moved toward object.
15th week.	Observation of hand and object while grasping.[81]			
16th week.	Hands moved toward object seen.[82]	Observation of object in hand; watching fingers while touching or grasping.		
17th week.	Good mouth grasping.			
18th week.	Grasping object seen, rare and groping movement.[83]	Hands moved toward object seen.	Watching own hand movements.	Grasping object seen, rare and little guided by sight.
19th week.		Grasping object seen, rare and groping movement.	Hands moved toward object seen. Good mouth grasping.	
20th week.	All objects grasped for confidently.			
21st week.	Objects handled, not carried at once to mouth.[84]			
22d week.		All objects grasped for confidently.		
6th month.				All objects grasped for confidently.
At 6 months.	Mouth-grasp disappearing.		All objects grasped for confidently.	

[79] See also a comparative chronological table, I, p. 405. Where these two tables differ (mainly in interpreting the notes of other records), the present one is to be regarded as the more carefully studied; but the table on p. 405 was, in any case, prepared to show the motor development chiefly; the present one, the progress in sense perception.

From the table above I have omitted Mrs. Moore's record, on account of several perplexing precocities. I give it here:—

	Girl.	*Boy.*
9th week.	Hands moved toward object seen.	
10th week.		Looking at hand and object.
12th week.		Hands moved toward object seen.
15th week.	Watching own hands.	
17th week.		Hands watched while grasping.
18th week.	Grasping well established.	Grasping well established.

By incorporating the fragmentary records given in footnotes with Table X(*a*), and omitting a few precocious and more or less doubtful instances, I find the records in my hands are really in striking agreement so far as shown in the following summarized tabulation:—

TABLE X(*b*). TABLE X(*a*) CONDENSED AND GENERALIZED.

AGE OF CHILD.	PROGRESS IN VISUALLY GUIDED GRASPING.
Twelfth to eighteenth week (usually, early fourth month).	Watching the movements of the hand attentively; or watching the hand and object while grasping.
Fourteenth to nineteenth weeks (usually, late fourth month).	Hands are moved vaguely toward the visual object, apparently without definite idea of grasping.
Seventeenth to nineteenth weeks (early fifth month).	Grasping visual objects—movement rare and groping.
Eighteenth week to six months (usually, late fifth month).	All objects grasped for confidently.
Twenty-first week to seventh month.	Objects are handled, not carried at once to the mouth.

Although the parallel is not so close here, the general type of the development; through watching the hands, and through groping movements toward the object, before visual direction and tactile-motor direction come into unison, is evident enough.

I append also my nephew's record, made too late to incorporate into the table:

13th week: Observation of hand and object while grasping.

15th week: Hand moved toward object seen.

16th week: Fairly good mouth-grasping.

17th week: Grasping object seen, rare and groping movement.

[80] First child, 14th week. Watching own hands also reported 9th and 10th weeks by Mrs Daniels and Mrs. Moore; 13th, Mrs. St. John; 15th, Mrs. Moore; 15th and 16th, Mrs. Saunders; 16th, Schulte (quoted by Preyer); at 4 months, Mrs. Cook.

[81] Watching hand and object, Mrs. Hall (precocious instance), 10th week; Mrs. Daniels, 12th; Mrs. Catterall, 13th.

[82] Moving hand toward object, Mrs. Moore, 9th and 12th weeks; Mrs. Hall, 16th; Mrs. Beatty, 17th.

[83] Mrs. Tilley (elder boy), 17th week; Mrs. Daniels, 4 months; Mrs. Cook, 5 months; Mrs. Hall, Mrs. Catterall, 18th week; Mrs. Beatty, 19th week; Tiedemann, 5th month; Sigismund, 19 weeks; Mrs. St. John, 20th week.

[84] Mrs. Saunders, 23d week; Mrs. Sharp, 29th week. I can not find definite statements in other records as to the date at which this advance took place; but that it did take place somewhere about the close of the first half-year is always made evident enough.

IV. AUDITORY ASSOCIATIONS.

The organization of auditory sensations must differ greatly from that already traced in the visual and tactile fields. For in these two fields, the essential process is the associative synthesis of two different sets of sensations,—the one set due to the impact of stimulus on the sense-organ; the other to the movements of the organ in adjusting itself to stimulus. No such synthesis can be looked for in the case of the ear, where (beyond the mere turning of the head to listen) there is nothing corresponding to active sight and active touch. In the passive reception of complex systems of stimulus (viz., music and speech), the ear does attain great psychic importance; but until the brain is ready to comprehend music and speech, hearing can be little more than a warning adjunct to vision.

As I have pointed out (pp. 30–31), it is improbable that cochlear hearing exists at all in the newborn infant; and up to the 5th week I could not find indication of it; nor do I find clear evidence of it earlier than the 3d week in any record. A few instances are given, it is true, of reaction to voices, and to whistling; but these reactions were of a sort that indicated jarring or shock, and the sounds may have been sudden and harsh. With a single exception,[85] the voices were those of men, at which young babies often start as if at a jar.

On the whole, the evidence is fairly uniform that modulated tones, especially musical notes, are attended to about the end of the first month.[86] From the first time they are noticed, they give pleasure, and are therefore well adapted to enter into associations under hedonic influence. From this time, hearing

[85] Mrs. McLeish's little girl, at *14 hours old,* stopped fretting when talked to in a soothing tone. In view of my own repeated failures to obtain reactions to modulated tones (I, pp. 107–108), and of Flechsig's report as to the condition of the cochlear nerve in the newborn, I think we must consider this solitary instance as mere coincidence. Since the above was in type, I find a note in Mrs. Conard's record that reports a similar reaction on the 5th day; but the incident was merely related to the mother by some one else, and seems to me quite doubtful. In any case, the reaction seen in a young infant when some one comes up and speaks to him is more likely to be visual than auditory.

[86] See Table XI, pp. 129–130.

begins to be drawn into the growing psychic complex, ***not at first by the development of a series of auditory association groups, but by associations with the groups already formed in the visual and tactile fields.***

1. ASSOCIATION OF SOUND AND SIGHT.

Face and Voice.—At the close of the first month or thereabout, when cochlear hearing first begins to give pleasure, the mother's lullaby and other sounds of voices about the child supply the principal auditory stimulus. It is also just the period at which the baby has made sufficient progress in fixation to form the habit of gazing constantly and attentively at the faces that bend above him (I, p. 79). The association of vocal sounds with the sight of faces is inevitable,—the more as his attendants answer his gaze by laughing, cooing, and prattling to him. That a rude association of the sort is in fact made, is shown by the way in which babies at this stage fix their eyes on a face with marked attention *during the continuance of a sound.*[87] They are as likely to watch the eyes, the most brilliant and motile features, as the lips; indeed, my niece watched our eyes while piano notes were struck, as other babies do when they hear singing, and Mrs. Tilley noted the same thing. That is, they do not look at the face because it is the source of sound; on the contrary, it is from watching the face while hearing the sound that they come to think of it as the "source."

Other Sounds and Visual Objects.—In the latter part of the second month my niece began to watch several moving objects, while listening to the sounds they produced,—the piano-keys (or more likely, the hands moving over them), rattles shaken before her, etc. (I, pp. 108, 109). This incipient stage of the association is inconspicuous, and it is not until the baby turns his head toward a sound, shakes a rattle purposely, etc., that the observer's attention is likely to be drawn; still, I find good evidence in one or two records that such a stage does precede the actual association of the sound and sight.[88]

[87] I, p. 109; see also Preyer, *op. cit.*, p. 83, and MS. records of Mrs. Tilley and Mrs. Cooley.

[88] Mrs. Tilley's boy gazed at the piano keys while hearing music (5th

Later, there appears a certain *expectation* of visual experience upon hearing any sound. My niece showed it first at 13 weeks old (I, p. 109); I find no instance of an unmistakable and well-fixed expectation of the sort before the 11th week.[89] It was not at all constant, in my own observation, before the second half-year, but some children are recorded as turning instantly to look, on hearing any sound, in the 5th and 6th months, and even by the end of the 4th. The difference may have been due to difference in interest, in keenness of hearing, or in firmness of the association.[90]

Sound and Visual Direction.—But there is another association shown when a baby begins to turn and look upon hearing a sound, besides that which lies in the mere expectation of a sight: an association, namely, by means of which the quality

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and 8th weeks—before he had learned to turn toward a sound) just as my niece did.

Mrs. Hall has a remarkable note of the interest excited in her boy by the simultaneous stimulation of the senses of sight and hearing. "57th day.—When a rattling box of matches was held before him, he stopped fretting and looked uninterruptedly at it for 6 minutes; the rattling was then discontinued and the crying began, but ceased again at the sight and sound of the rattle-box. On the following day his attention was fixed upon it for 8 consecutive minutes. 62d day.—A purse containing coins was shaken up and down before the child. For the first 6 minutes he gazed at it with knit brows, then his face cleared; he looked pleased, then laughed and made excited motions with arms and legs. He continued this for 28 minutes, when although he did not remove his eyes from the purse, he fretted slightly. At the end of 30 minutes his eyes were still fixed upon the object, but as he seemed very tired, it was removed from his sight." (*Op. cit.*, p. 458). By a purely visual interest his attention was held at this time not more than 3 minutes. Mrs. Hall concludes: "The attention is held much more closely when two senses are affected than when only one is affected"—a condition of simultaneous tension in two sense-centers very favorable to the opening up of associative connection between them.

See also the observation on my nephew, p. 124, note 91.

[89] Earlier instances of the apparent association of a voice with expected attentions, as when the baby smiles or stops crying on being spoken to, may be due to mere diversion of attention, or to pleasure in the sound itself, or to visual suggestion, *op. cit.*, Mrs. Moore, p. 67.

[90] The *recognition* of a voice—distinguishing one from others, and associating it with visual and touch memories of the proper person—involves much more than mere association of sound and sight, and belongs to a later period of development.

of the sound suggests the *direction* of the sight, in visual space. This seemed to me to come about with surprising suddenness, without preliminary stages; yet it had the appearance of intelligent action, not of an inherited reflex (I, p. 109). It was the more surprising, since the baby had but just begun to look for objects, guided by visual memory. Dr. Stratton's experiments[90a] have made it evident that even in mature persons there is no essential and instinctive connection between the direction from which a sound reaches us and the visual feeling of direction; that it is only by experience we learn to associate a certain quality in sound with the way in which we must turn our eyes to see its source. It is perplexing, then, that a three-months' infant could turn her head and look in the right direction, upon the first trial, at the sound of a snapping fire, a sneeze, etc.

I have no doubt that I failed to observe the early stages of the development, and other records supply the missing chapter in mine. Preyer, Vierordt (quoted by Preyer), Tiedemann, Mrs. Moore, Mrs. McLeish, Mrs. Tilley, Mrs. Hall, Mrs. Catterall, all mention the movement at first as a mere turning of the head in the *general direction* of a sound. Several observers (Sigismund, Moore, Tilley, Catterall) record the sound of a voice, or of an approaching person, as the first one that suggests this turning. Now by the end of the first quarter-year the child has already learned to look for the faces and forms of his attendants in a few familiar localities; has many times watched their faces to right or left of him, above or before him, while at the same time hearing their voices; has seen them enter and approach, at the same time hearing their steps. That the sound of voices or steps, in a few familiar localities, should suggest the accustomed image *in the accustomed place,* is to be expected, so soon as the associative connection between visual and auditory centers is at all functional; and it must be coming rapidly into function during the third month, under the tension produced by the constant attention to simultaneous visual and auditory impressions. And in fact, the first unmistakable evi-

[90a] "Vision without Inversion of the Retinal Image," *Psychological Review,* Vol. IV, pp. 341–360 and 463–481.

dence that a sound suggests expectation of a sight, shows it suggesting also the direction of the sight, as the baby turns to look.

It may be conjectured that at first the child, at sound of any voice, looks only to the accustomed region for his mother's or nurse's face; that later, repeated experience leads him so far to associate sounds right and left, below and above, with the true direction in visual space, that on hearing a voice he turns his eyes correctly to faces *already within the marginal field of vision;* and only later extends the association, and turns his head farther in the same direction, looking for the visual "source" (that is, the expected concomitant) of sound. All this conjecture waits for further and closer observations; yet it is not wholly without corroboration.[91]

[91] "By the 18th week," Mrs. Moore records, "he could locate very well sounds coming from objects *within the visual field,*" (the italics are mine).

Mrs. Tilley's record of her younger boy gives the best clue we have yet had to the general process of learning the association. In the 10th week, the child occasionally turned toward a sound, once or twice only looking correctly at its source; by the end of the 12th, his mother became satisfied that the sound of people entering made him turn and look toward the door—the direction in which people had always been seen while these sounds were heard. He could not, however, look correctly toward a person speaking or calling until the 13th week. By the 18th, he located sounds quite well.

I pass over a note by another hand, relating to the same baby, according to which he looked from speaker to speaker, on the 25th day; and Mrs. Moore reports on the 30th day that her baby "undoubtedly" turned his head in the direction from which sounds proceeded. Yet these same babies are later, in their 3d and 4th months, recorded as but gradually and imperfectly learning to look in the direction of sounds. Whatever this early turning may be, it certainly is not the intelligent association of sound with the visual direction of objects. There seems to be a slight reflex tendency in the newborn, in the auditory field as well as in the visual and tactile, to movement toward stimulus. This tendency has faded away (so far as my own record or any other indicates) long before intelligent "looking for the source of a sound" is noted; but some trace of it may remain and combine with acquired experience in giving the look its proper direction; as I have suspected a similar instinctive element in the earliest grasping upon visual suggestion (p. 107).

Certainly all recorded instances of looking in the direction of a sound earlier than about the end of the 3d month, were imperfect, irregular, transitory, or were cases of the association of a single well-known sound with the invariable position of its visual accompaniment, as when my

2. ASSOCIATION OF SOUND WITH SOUND-PRODUCING MOVEMENTS.

Hand Movements.—I need not dwell on the simple associative process by which the sound of a rattle shaken, of paper crumpled, of the scratching of finger-tips across paper, etc., comes to be linked to the accompanying series of tactile-motor sensations, then to be suggested by the touch of the object, or by its weight in the hand, till the baby becomes able to repeat the movement voluntarily. My own record reports the voluntary repetition of such chance noise-making movements in the 13th week; others, usually between the 13th and 16th weeks; Professor Preyer's[92] not until the 19th. It is months later, however, that the conspicuous pleasure in making a noise develops, and in all these early instances sensations of weight and of active touch are probably

niece watched the piano keys in the 9th week, or Mrs. Tilley's boy looked toward the door when he heard people enter, in the 12th.

Since the foregoing was in type, I have seen in my nephew a gradual process of association between sound and sight, much like what I had conjectured. In the 9th week I noticed that his attention was held more intensely by a visual object when he was listening to sound; the visual and the auditory experience seemed both to be noticed, and with a sort of excited curiosity, as if there were an effort to bring them into a unified perception. In the 10th week, on hearing a sound, the boy would seek slightly with his eyes, and fix them on the first noticeable object they found,—a face, a light tract on the ceiling, a bright dish on the shelf,—and regard this with intensified interest while the sound continued. But in the case of voices, I thought his manner showed a certain satisfaction if it was a face that his eyes found, and lacked it when he tried to bring the sound into connection with any other visual object. He once looked back and forth several times, as if in perplexity, between my face in the marginal field, and a bright tract on the ceiling, to which he had looked when I called him. In a few days he learned to turn, at first slowly and gropingly, then quite accurately, toward a face, and then toward other sources of sound, *within the visual field*, but not outside it. In the 11th week, I called him from just outside the visual field. He looked at the ceiling, fretted, and seemed to struggle, with straining movements of the body, to recover the missing element in the association; turned his head to and fro; then slowly and uncertainly in the right direction, till he found my face. The quality of the sound had come to suggest the visual direction without the help of the marginal image. It was not until the 19th week, however, that I saw him turn to search for the "source of sound" far outside the visual field; and then without accuracy, merely in the general quarter whence the sound proceeded.

[92] See Table XI, p. 129.

sought by the movements quite as much as those of sound. But not far from the same time the infant forms an association of sound with movement which is of far greater interest to himself, and of far more psychic importance,—he learns the use of his own vocal organs.

Movements of Vocal Organs.—Before the middle of the first quarter year, 6th week, I observed that the monotonous cries of the newborn period developed into sounds much more varied, when the heightened innervation due either to pleasure or discomfort stimulated the vocal organs. By the 16th week, there was plainly voluntary effort to repeat these sounds, accompanied by a great deal of attention and enjoyment; indeed, the pleasure of this exercise was comparable to that enjoyed in visual experience. The coincidence of feelings in the baby's own throat and mouth with the ensuing sounds was evidently far more pleasureable than any production of sound by hand and arm movements, —perhaps because mouth and throat sensation was still much in advance of hand and arm sensation in the permeability of the centripetal paths and the maturity of the cortical cells; perhaps because the vocal exercises gave a more elaborate and varied set of coincidences between two departments of sense, so that the relation between effort and result attracted some real apperceptive attention, such as was already showing itself in visual observation (p. 67).

The immense importance of this stage in auditory associations is at once apparent, for it is the first step toward the acquirement of speech. It has been recorded by a number of observers,[93] and I have no doubt that it occurs invariably. It is, however, hard to fix the date at which the sounds become a voluntary exercise;[94] the fourth month seems fairly enough indicated, however, as the usual period (see Table XI).

[93] Mrs. Tilley, Mrs. Cook, Mrs. Daniels, Mrs. Catterall, Mrs. Conard, MS. records. *Op. cit.*, Mrs. Hall, p. 587; Taine, p. 24; Darwin, p. 39; Tiedemann, p. 24. Preyer, The Development of the Intellect, pp. 102–105, 240. The Biography of a Baby, pp. 87–88, 137–138.

[94] Prof. Sully hints at a process of association-forming here, precisely similar to that which I traced in detail in the visual field: first, the maintenance of a given innervation under influence of pleasure; next,

3. EARLY AUDITORY INTERPRETATIONS.

Auditory Contributions to Space Interpretations.—Any *direct* space interpretations in the auditory field must be of the most rudimentary sort, since the organ of hearing offers no means of space measurement through alliance with muscular sensations, beyond the mere turning of the neck. Our own strong feeling of sounds as arising in a definite location in space, traversing space in a line of direction, and reaching us from that direction, seems to be wholly conceived in visual-motor and tactile-motor terms, and as the result of long experience in relating given qualities in sounds to given positions of the sounding object, as shown by sight and touch. It is impossible that the baby, when he first turns to "look in the direction of a sound," or to "seek its source," can have any such secondary and transferred space-feeling connected with it; for the primary space-interpretations of the eye and hand themselves are but beginning to form at this period, the third and fourth months (pp. 71–72, 92–93).

Yet it is possible that these eye and hand interpretations do, in the very act of forming, receive a slight re-enforcement from the experiences of the ear. The differences in sound given out by a known object, according to its position or distance, especially the *changes* in sound as the object moves to and fro, advances or recedes, may emphasize the visual-motor and tactile-motor distinctions of position, direction, and distance, which

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its mechanical repetition; finally, the establishment of hedonic associations, capable of suggesting the movement as a voluntary one. He says: "We see the germ of such a pleasure-seeking babbling in the protracted iteration of the same sound. The first reduplications and serial iterations, a-a, ma-ma, etc., may be due to physiological inertia, the mere tendency to move along any track that happens to be struck. . . . At the same time, there is without doubt in these infantile iterations a rudiment of self-imitation." —"As this impulsive articulation develops, it becomes complicated by a distinctly intentional element. The child hears the sounds he produces, and falls in love with them. From this moment he begins to go on babbling for the pleasure it brings." *Op. cit.*, p. 137.

So also Prof. Groos:—"Der instinctive Drang nach motorische Entladung fuhrt auch zu Bewegungen der Kehlkopf- Mund- und Zungenmuskeln, und das Kind, das sich an den so erzeugten Tonen ergotzt, ist bald in vollen Experimenten begriffen." Die Spiele der Menschen, p. 38.

are just becoming formulated.[95] This would be so most of all in the case of the human face and voice.

As the second half-year goes on, and the exploration of the external world by joint use of hand and eye and body movement is well advanced, the baby shows that he understands very well the difference between hearing a well-known voice at hand or in the next room (I, p. 111). In the earlier period of which we are speaking, however, there is no indication that the ear contributes anything to the inference of distance.[96] To that of direction it should, so decided is the association of sound with visual direction in the second quarter-year.

Objective Source of Sound.—At three and four months old, when objects are but beginning to be definite and located outlines to the eye, and are still only slightly associated groups of tactile-motor sensations to the hand, there can be no conception of an objective source of sound, in the sense of any notion of sounds as proceeding from, or caused by, objects. But when the infant of this age turns intelligently and expectantly to look for a located sight, upon hearing a sound, it is hard to doubt that he imports into the auditory experience something of that feeling of externality and position that the visual outline is already gathering about itself. And on the other hand, the thing seen must seem more real and external when the close association of auditory experience with it has extended that "parallax" of disparate senses on which our conviction of external reality seems so largely to depend.

Just what relation the sound tends to take to the sight in the baby's mind, it is hard to guess. It seems likely that for a time there is a tendency to fuse the auditory and visual experiences into the conception of an object visible and audible, just as it

[95] It is true that it has never been observed that deaf infants are slower in forming these space perceptions; on the contrary, it is commonly remarked that they behave so exactly like normal children that their deficiency is likely to escape detection till the period when speech should begin. It may be, however, that closer observation would reveal significant differences even in visual and tactile perceptions.

[96] Mrs. Moore says decidedly that her child at this stage could make no inference of distance from sound.

is visible and tangible. The disposition to look for a sight with *every* sound[97] may be due to this. If there is such a tendency, however, it must soon be broken up by the irregularities in the occurrence of sound and sight together, the association of some sounds with visual objects, others with feelings in the vocal organs, others with hand and arm feelings, while still others, from invisible external sources, remain unassociated. But see p. 193, as to interpretation of sound in the second year.

4. SUMMARY AND TABLE.

The auditory development, then, up to the period at which the main synthesis of the higher senses was accomplished, was as follows:—

First: In the newborn condition, lasting some four weeks, the baby received passive sensations of auditory jar, through the semicircular canals, from any sudden or harsh sound.

Second: From the 5th week, cochlear hearing was established, and the baby received agreeable tone sensations, especially from notes of music.

Third: Almost immediately, these tone sensations began to be associated with the visual experiences regularly received in connection with them; such associations were becoming fixed, and somewhat varied, from the 5th to the 13th week.

Fourth: By the 13th week, the differences in sounds, according to the direction from which they reached the ear, had begun to suggest the visual direction of the object, so that the head could be turned correctly to obtain the suggested visual experience.

Fifth: From the 13th week also, an association became apparent between sounds produced by hand-movements, and the feeling of these movements; so that upon touching a suitable object, the movement was suggested and the sound produced voluntarily.

By a similar association between the tactile-motor feelings of the vocal organs and the sounds produced by them, the baby became able by the 16th week to make vocal sounds at will.

Sixth: No direct auditory interpretations or inferences con-

[97] My niece, when first making vocal sounds with intention, in the latter part of the 4th month, was disposed to gaze into our faces, as if she referred her own grunts and cooings to them.

TABLE XI (*a*). EARLY AUDITORY ASSOCIATIONS.

Age of Child.	Stage of Development, Observed by					
	Shinn.	Preyer.	Hall.	Tilley, 1st Child.	Tilley, 2d Child.	Catterall.
1st two weeks.	Sensibility to auditory jar, no true cochlear hearing.					
3d week.				Pleasure in musical tone.		
4th week.				Association of sound with face.	Pleasure in musical tone.	
5th week.	Pleasure in musical tone.[88] Association of sound with face.					
6th week.		Pleasure in musical tone. Association of sound with face.				Pleasure in musical tone.
9th week.				Vocal sounds purposely made.		
10th week.					Looking in direction of sound, acquired gradually, 10th–13th weeks	
11th week.		Looking in direction of sound.		Sound made purposely by hand.		
12th week.						
13th week.	Looking in direction of sound.[89] Sound made purposely by hand.[89a]					
14th week.						Looking in direction of sound.
15th week.			Vocal sounds purposely made.			Vocal sounds purposely made.
16th week.	Vocal sounds purposely made.[89b]		Sound made purposely by hand.			
18th week.					Sound made purposely by hand.	
19th week.		Sound made purposely by hand.				
21st week.			Looking in direction of sound.			
22d week.		Vocal sounds purposely made.				

[88] Mrs. Moore, 3d week; Mrs. Cooley, 6th week or earlier; Mrs. Conard, 6th week; Mrs. McLeish, Miss Shinn (nephew), 7th week.

[89] Mrs. Moore records automatic or precocious looking in the direction of sounds, 5th week, but intelligent looking not before the 18th (see p. 123). Mrs. Conard saw it incipient in the 13th week, and unmistakable in the 14th; I saw it incipient (nephew) in the 11th, and unmistakable in the 19th. Mrs. McLeish records the habit as well established in the 13th week. Mrs. Wood reports it in the *3d week*,—undoubtedly automatic; Sigismund "in the second quarter-year" (*op. cit.*, p. 29); Preyer quotes Vierordt as placing it in the 4th month (*op. cit.*, p. 91); Mrs. St. John saw it "at about

cerning the external world could have been made; but the visual interpretation of direction may have been re-enforced by association with sound, from the 4th month on.

Seventh: From the beginning of the 4th month, sounds were probably felt to be external, but could not have been understood as *proceeding from* objects; there may rather have been a passing tendency to *identify them with* the visual object.

None of the auditory associations were very firm, nor was marked interest and attention aroused by auditory experience, except in the case of vocal sounds produced by the baby herself.

When it is considered that all the notes of looking in the direction of a sound earlier than about the end of the third month prove on examination to refer to imperfect and incipient instances of the action, or even to survivals of a mere primitive reflex (p. 31, note 48; p. 123, note 91), and that the late date assigned by Mrs. Hall seems to refer to an advanced stage of the habit, it will be seen that there is a good agreement among the records (Table XI (*a*) and footnotes). They indicate substantially the following as the *average* course of development:—

TABLE XI (*b*). Table XI (*a*) Condensed and Generalized.

Age of Child.	Auditory Development.
1st month	Sensibility to auditory jar, non-cochlear hearing.
5th or 6th week	Sensibility to modulated tones, especially musical ones, with full attainment of cochlear hearing.
5th or 6th week (later)	Association of sound with the mother's face, following close on the preceding development.
3d month	Association of sound with visual direction, developing throughout the 4th month.
4th month	Producing sounds voluntarily, by hand and by vocal organs.

16 weeks,'' Mrs. Daniels at 4 months, Tiedemann at 4 months and 10 days (*op. cit.*, p. 26), Darwin at about 17 weeks (*op. cit.*, p. 33), Mrs. Cook at ''nearly 5 months.''

[99a] Daniels (girl), 12th week; Mrs. Conard, 13th; Miss Shinn (nephew), 15th; Daniels (boy), at 4 months; Saunders, 23d week.

[99b] McLeish, 9th week; Miss Shinn (nephew), 12th; Mrs. Conard, 16th; Tiedemann, 5th month; Mrs. Daniels, Mrs. Cook and Sully, 6th month.

V. ASSOCIATIONS OF THE MINOR SPECIAL SENSES.

The senses of taste and smell, and the minor dermal senses, need hardly be considered here at all, so little part do they play in the early synthesis of sense-experience by which the external world takes on its main order to the baby's perception. For one thing, the opportunity for their exercise is slight in the early months, and such sensations as they do afford are of a neutral sort. A young infant does not normally experience skin hurts, nor decided heat and cold, nor any tastes except that of milk, and as he is unable to inhale voluntarily, few odors reach the olfactory nerve. Under such conditions, the powerful hedonic impulse is wanting, and associations are slow to form.

1. RECOGNITIONS BY TASTE, SMELL, OR PAIN ASSOCIATIONS.

In the very early association with the nursing position (first month, p. 54, and I, p. 213), the satisfaction of hunger is undoubtedly the determining hedonic element, and the same thing may be true in the recognition of breast, nursing-bottle, etc., about the beginning of the second quarter-year. I noted no instance of the recognition of a visual object by an unmistakable taste association before the 6th month, but no doubt the association can be made earlier, and one good observer has given me an instance occurring in the 3d month.[100]

Of any sort of smell association no valid instance is known to me within the first year of life.[101]

Pain associations seem first to come into play as teachers of caution when locomotion begins,—about the 8th month, in my observations.[102] Incautious movements are quickly associated with resulting bumps. The association of pain with a visual object is rarer.

[100] Mrs. Helliwell of Milwaukee. This early recognition was due to the use of a medicine. Mrs. Tilley's record, like mine, fixes the recognition in the 6th month. In other records I cannot distinguish between the food association and the pure taste association.

[101] Mrs. Moore was satisfied that from the end of the 1st month the smell of milk suggested feeding to her child (*op. cit.*, pp. 83–4), but this is uncorroborated, and in direct opposition to Prof. Preyer's observations (*op. cit.*, p. 134). I too found that instead of receiving suggestions of food from the immediate presence of her mother, my niece would as readily stop her cries when lifted to the nursing position on any one else's arm (I, p. 213).

[102] At 9 months, Mrs. Moore; at 10 months, Mrs. Beatty.

2. INTERPRETATIONS.

It is not hard to see how a baby must come to the interpretation of tastes, smells, and the minor dermal sensations that we find in our own consciousness,—that is, to the feeling that they are experienced on our own body surface, but caused from without. But observation adds little to our analytic conclusions about the process.

Tastes cannot fail to be associated early—as early as they attract attention at all—with the well systematized touch perceptions about tongue and lips. As these become localized in consciousness, the taste perceptions must be roughly localized with them, so far, at least, as to be referred to the mouth interior. Almost as early, the sight of bottles, spoons, etc., becomes associated with food, and with tastes as soon as taste becomes an important element in the enjoyment of food. This is certainly by the 6th month, perhaps earlier. By this date, there must be a well established somatic consciousness of the mouth region (p. 137), and some sort of conception of an external object, visible and tangible. The baby may therefore perceive tastes much as we do, as belonging somehow to the external object, but realized in his own mouth.[102]

Interpretations of smell sensations must come about in much the same way, but slowly. Far on in the second year, they are referred to the nose with much difficulty, and mainly by means

[102] This analysis can readily be carried further. The taste sensation is always accompanied by contact sensations in the mouth; but the converse is not true, for the baby has immense experience of feeling tasteless objects in his mouth. Hence any tendency to the fusion of the taste and touch sensation into a single consciousness is checked, and we can find but rudimentary instances of it, though such fusion is frequent between taste and smell. Again, the visual-tactile object is so irregularly associated with taste (and never simultaneously) that taste representations are never really *fused* into the conception of an object. Yet in the case of objects that are regularly associated with tastes, the child comes eventually to regard the taste as somehow inherent in the object. So, too, heat and cold come to be felt inherent in the object, though experienced in the body-surface; but pain as only caused by the object. All this is old ground, and is outside the scope of a report from observation. It is only pertinent to point out that these finer distinctions in distributing the reference of experience between the self and the object, must be developed slowly. They may not be complete much before our memory of them begins.

of the acts of holding an odorous object to the nose, and of sniffing (I. p. 176).

There are some indications of difficulty in the reference of pain to the body-surface instead of to the external object, as late as the 11th month (p. 139, note 115); and late in the second year, there is difficulty in localizing them.

VI. FEELING OF A BODILY SELF.

In the preceding chapters I have traced minutely the organization of sense data by which the external world takes on its permanent order in the baby's consciousness. But if it does indeed seem to him an external world, there must be going on at the same time another organization of sense data into another large, complex consciousness,—that of a bodily self; for we cannot conceive a feeling of externality that does not imply the converse feeling of internality.

The sensations on which our own body-feeling rests are experienced from birth (pp. 42–45), and I see no reason to doubt that they begin early to be grouped together and differentiated from the sensations externally referred; but as to the steps of the process I have little to report from observation.[104] In general, it must consist of (1) becoming aware of control over the movements of the body; (2) associating the body-control feeling with equilibrium sensation; (3) differentiating the body-surface from other objects of sight and touch, by its system of double sensations; (4) differentiating the body-interior sensations from those of the special senses, by their lack of systematic intercentral association, through which the experiences of one sense could be verified and measured in terms of another; (5) the integration of all these perceptions into the large and complex consciousness of the somatic self.

1. CONSCIOUSNESS OF MUSCULAR CONTROL.

I am disposed to think this the earliest form in which the feeling of a bodily self dawns on the infant. It is, of course, wholly unreflective, consisting only in an association between

[104] The general discussion of self-consciousness would carry us far beyond the domain of the senses. I cannot wholly omit mention here of the primitive somatic consciousness; but I shall confine myself as closely as possible to its purely sensory aspect.

the feeling of central effort and the perception of the resulting movement. Or, to put it still more primitively, it is an association of those feelings of attention and pleasure that discharge the first voluntary movements with the resultant muscular sensations. This association, we may suppose, begins with the first voluntary direction of the eye to a marginal image, and becomes fixed as the habit of voluntary movement grows. By the time that voluntary movement is initiated with visible *effort* (as when my niece at three months old tried hard to sit up), the central factor in the association must have become quite distinct in consciousness; and by the time that movements are experimented in and watched (as when other babies, at three and four months old, turned the hand this way and that, watching it move), the whole association must be strong, and the child must have a clear (though unreflective) feeling of his own muscular control.

We may safely suppose, too, that this muscular-control consciousness will extend over the body step by step, following upon the appearance of voluntary movement in any part. The dates at which control over the bodily movements appeared, in all observations available to me, are given in the following table.[105]

[105] In studying the records of others, I cannot always tell whether the movement recorded was voluntary or not; nor whether it was the beginning of the development, or an advanced stage. I have therefore been obliged to omit a number of comparative instances that I should have liked to use, had they been definite enough.

Where a double date is given in Table XII, the second is that of fairly complete control over the muscles. All other dates are those of the first recorded sign of control.

[106] Preyer himself sets the first voluntary control of the neck muscles (holding up the head) in the 11th week; but he saw intelligent direction of the eyes, and turning of the head to aid the look, as early as the 4th. It is perhaps impossible to say at what stage a movement like this is to be called strictly "voluntary"; but it is enough for the present purpose that the action should be performed with such intelligence and attention as to fix an association between the central impulse and the resultant movement feelings.

[107] I take no account in this table of the control of tongue and lips for purposes of enunciation (16th week to 3d year, or even later). The earlier and easier use of them for active touch and grasping was sufficient to develop the consciousness of muscular control over them. It began probably,

TABLE XII. VOLUNTARY MUSCULAR CONTROL.

Control Attained Over	Date.	Observer.
Eye muscles	3d–5th week	Moore
	3d–8th week	Shinn (boy)
	4th–7th week	Hall
	4th–9th week	Preyer, Shinn (girl)
	4th week	Conard
	5th–7th week	McLeish
	5th–8th week	Tilley
	5th week on	Sigismund (girl), Beatty
	7th–10th week	Sigismund (boy)
Neck muscles	3d–10th week	Shinn (girl)
	3d–25th week	Moore (girl)
	4th week	Preyer, Conard[106]
	4th–16th week	Shinn (boy)
	6th–17th week	Moore (boy)
Tongue and lips[107]	7th week	Shinn (girl), Tilley
	8th week	Shinn (boy)
Arms	5th week	Moore (girl)
	6th week	Moore (boy)
	7th–10th week	McLeish
	8th–20th week	Hall
	9th–20th week	Shinn (girl)
	11th week	Sully, Shinn (boy)
	13th–22d week	Tilley
Trunk[108]	8th week	Shinn (boy)
	9th week	Shinn (girl)
	10th week	Hall
	11th week	Sully
	12th week	Moore (girl), McLeish
	14th week	Moore (boy)
	15th week	Tilley
Hands	8th week	Tilley
	10th week	Moore, McLeish
	11th week	Shinn (boy)
	12th week	Shinn (girl)
	13th week	Hall[109]
Legs	10th week	Hall
	11th week	Shinn (boy)
	13th week	Shinn (girl), Conard
	15th week	Tilley
	16th week	Moore

in my niece's case, in the 4th week, but was not noted till the 7th (pp. 78–80); it was practically complete within the 2d month.

[108] It is especially hard to know how early movements of turning over or of stiffening and raising the trunk are voluntary; for such movements (like those of lifting the head) are certainly sometimes made by young infants spontaneously, at moments of high general innervation. The instance used in the table from Mrs. Hall's record (*op. cit.*, p. 401) seems to me doubtful; on the other hand, I have passed over instances that *may* have been voluntary, in Mrs. Tilley's and Mrs. Moore's records, as early as the 7th week.

[109] Apparently not quite the earliest appearance of control (*op. cit.*, p. 396).

It may be safely concluded from this table that an infant will have a certain consciousness of control over eyes, neck, tongue, and lips, before the end of the second month; of the arms, hands, and usually of the trunk by the end of the third; and of the legs perhaps early in the fourth,—allowing in each case a little time after the incipiency of voluntary control, for the development of a sort of habitual control-feeling.

2. Equilibrium feelings.

The infant experiences equilibrium sensations from the first days of life (p. 42). With the beginning of voluntary efforts to balance the head (3d or 4th weeks, Table XII), these sensations must come into association with feelings of muscular control over the neck, and must take into themselves something of whatever quality of self-reference these feelings have. With efforts to straighten the back, and to sit up (3d month), they are again associated with the control-feelings of the trunk muscles. In the second half-year, when the movements of balance and locomotion are diligently acquired, the equilibrium feelings and control-feelings all over the body must be very closely associated.

3. Exploration of the body-surface.

From the first there is a great deal of unintentional exploration of some parts of the body-surface. The tongue moves over the inner mouth surfaces and the lips; the lips are in constant contact with each other; the hands clasp down on themselves, encounter each other, move across the face, and are laid hold on by the mouth,—and double sensations are regularly given by these contacts. In this way, even before any attentive exploration has begun, the infant's perceptions of his own mouth, face, hands (and to a less extent of all parts of his body that are often touched by his hands, and of his feet and legs as they touch each other), are differentiated in quality from those given by other surfaces. But attentive exploration soon begins. As early as the seventh week I saw my niece repeating, with evident attention, the movement of the tongue across the lips; and it is likely that some apperceptive attention is given as early

as this, also, to the touch feelings when the fingers are sucked. The muscular-control consciousness of the mouth, which is well established by the end of the second month, is thus re-enforced about the same time by tactile consciousness. And throughout the whole process of learning to carry the hand to the mouth, or to grasp it with the mouth by reaching with the head, strong associations, emphasized by a decided hedonic element, must be consolidated between the feeling of muscular control over hand, arm, neck, and mouth, and the double sensations of touch constantly received; while a systematic differentiation takes place between these double sensations and the very different sort of feeling experienced when an alien object is grasped and sucked.

As soon as the baby begins to watch his own hand while he feels it moving about or grasping, another type of double perception is experienced,—tactile-motor and visual (fourth month, see Table X (*b*), p. 118); and this still further differentiates his hands from those external objects of sight which cannot be at once seen in action and felt to act. As the co-operation of hand and eye increase, and exploration by the joint use of three departments of sense becomes habitual, the whole body surface is little by little investigated, and annexed to the domain of the somatic consciousness.[110]

The process is slow, however. It lasted in my niece's case certainly throughout the first year,[111] and even in the second

[110] As to the establishment of the whole system of "local sign" over the body by this co-operation of visual and tactile-motor observation, see Wundt, Human and Animal Psychology, Lecture X.

[111] 19th and 20th weeks.—Marked curiosity about a touch on the back of her head; constant effort to see what touched her.

20th–22d weeks.—Reached for her toes and played with them, feeling over her leg also.

22d–24th weeks.—Carried the toe to the mouth; an action requiring much co-operation of different muscles, and giving a greatly extended knowledge of her own body.

23d week.—Felt over the side and back of her head.

26th and 27th weeks.—Investigated ear, cheek, and side of the head constantly with the hand; also felt over the lips and gums with her fingers.

30th week.—Rubbed the forefinger investigatingly with the thumb.

32d week.—Hair was discovered, felt over and pulled with much curiosity.

year there was evidence of very imperfect local sign.[112] In its early stages, about the time that the child is acquiring the power of grasping, there is evidently great ignorance of his own body, and real confusion between it and alien objects of sense. During the period of tactile-motor grasping, my niece's hands, if they chanced to encounter each other, would each seize the other and try to carry it to the mouth; and rattle or fingers were constantly withdrawn unexpectedly from the mouth by attempts to flourish the arms.[113] With the coalescence of visual-motor and tactile-motor observation of the hand movements, this confusion passed away, and there seemed to be a fair self-consciousness, so far as hands and face were concerned. How it could have extended much beyond hands and face in the fifth month, I cannot see. In the sixth month, when the baby began to play with her toes, and even to perform the highly co-ordinated movements necessary to get them into her mouth and hold them there (I, pp. 317, 320–321), her knowledge and consciousness of her own body must have expanded immensely. This amusing movement, which it is hard to regard with scientific seriousness, is really of great importance to the psychic development. It seems to occur pretty regularly,[114] always in the early period of joint hand and eye investigation, about the sixth month.

34th week.—A habit for days of examining the tongue with the fingers.

11th month.—Habit of holding the head between the hands, as if to get impressions of its size and shape.

These investigations of head, neck, hair, and ear continued to the end of the first year. In the second year, experiments in pain were made on herself and others, giving valuable material for differentiation between the self and the alien body (14th–19th months).

See I, pp. 142–3, 317–8, 320–1, 152–3. Also *op. cit.*, Preyer, pp. 189–191; Mrs. Hall, pp. 530–1, 534; and MSS. of Mrs. Sharp, Mrs. Catterall, Mrs. St. John, Mrs. Tilley.

[113] A note of the third half-year says, "As a rule she could at this time remember being hurt, but not the place where she hurt herself," and gives several instances (I, p. 152).

[112] See also the citation from Mrs. Hall's notes, p. 103, note 73; and Preyer, *op. cit.*, p. 189. I noted many such confusions in my nephew's early grasping.

[114] Mrs. Hoyt saw it in the 5th month, and a few notes from the Hon. S. M. Franklin, of Tucson, Arizona, record that his daughter achieved it at the same age; Mrs. Tilley saw it before the end of the 5th month; Mrs. Wood

It is somewhat startling to realize that the baby's somatic self-consciousness can be so limited, at a time when his consciousness of the external world seems to be much the same as ours, to touch and sight. But a good somatic consciousness of mouth and hands alone is quite as capable of giving the contrast between self and not-self as a complete knowledge of one's own body would be. It is probable, however, that at this time—about the end of the first half-year—there is still a large part of the baby's sense experience that is not differentiated in his consciousness as external or internal, nor in any way localized. All the organic and general sensations may belong to this category.[115]

4. ORGANIC AND GENERAL SENSATIONS.

Sensations of this class enter early into loose associative connection with other sensations, so that the pleasures of food, or of the bath, can be suggested by the nursing position (1st month), the breast or nursing bottle (4th month), the preparations for the tub (2d month, Mrs. Tilley). But they are quite without those systematic associations, growing to fusions, by which we focus diverse senses on one object, and seem thereby to get our belief in its externality and reality. This difference between the two groups of sensations must begin to exist in consciousness from the time the system of intercentral associations begins in visual-motor perception,—that is, from the first active looking, late in the first month. But this alone could not give the organic

and Mrs. Helliwell in the 6th month, Mrs. Conard in the 27th week, Preyer in the 32d, Mrs. Hall in the 36th. Even if infants do not carry the toes to the mouth, they usually play with them a good deal; see records of Mrs. Moore, Mrs. Daniels, Mrs. Catterall.

[115] It is possible that even pain is late in clear reference to the bodily self. Mrs. Beatty's boy, at 10 months old, crying vigorously over a bump, called attention to it by pointing his finger at the wall where he had struck his head, not at the injured spot. This was very early in the process of acquiring the balance movements (I, p. 411); as this process goes on, the reference of pain to the body-surface may be coming about. Certainly the succession of muscular efforts, balancings, falls, and bumps, ought to bring pain experiences into pretty close relations with feelings of body-control and of equilibrium. But I have already mentioned the difficulty my niece found in localizing hurts as late as the second year, and of her curiosity in experimenting with pain, and comparing the effect of injuries on her own skin and on that of others (I, pp. 152–3).

sensations their distinct self-feeling, as we experience it. It is more likely that it leaves them as I have conjectured above, quite unlocalized and unreferred. To be self-referred, they must not only be differentiated from the perceptions of the external world, but integrated with those of the somatic self, already gathering about the consciousness of muscular control and of the skin-surface.

I can offer no evidence as to how this comes about. No doubt the process is aided by the acquirement of balance and locomotion; for the observed movements of the body, and the equilibrium and control feelings in standing and walking, could not but connect themselves in consciousness with the alterations they produce in feelings of visceral weight and of circulatory conditions. Probably the integration of all the feelings that go to make up the body-consciousness is slow, and hunger, suffocation, etc., may not be distinctly referred to the body-interior till reflective consciousness has arisen.[116]

VII. TABLE AND RECAPITULATION.

By omitting from consideration the minor departments of sense, it will be possible to present in a fairly clear tabulated form the synthetic development traced in the preceding chapters. In this table I have generalized the chronology of development, so as to conform it not to my own record alone, but to that of all the records I have examined, as in Tables VIII(*c*), IX(*b*), X(*b*). I have introduced my interpretations of the stages of development, but these are distinguished from the pure facts of observation by printing the latter in heavy-face type.

The tabulation becomes fairly complete by the addition to it of the association of sensations of taste (beginning about the third month), smell (second year), and heat and cold, with ob-

[116] In using sign language, in the second year, babies always indicate the mouth, I think, not the stomach region, to express hunger. My niece at 18 months old seemed hardly to understand the word "eat" as distinguished from putting into the mouth, and even confused it with "kiss" (I, p. 226). A few weeks later (81st week) she located nausea, or else the muscular sensation of vomiting, correctly enough (I, p. 235). Up to the end of the 3d year, she did not use words of organic sensation intelligently.

TABLE XIII. ORGANIZATION OF SENSE DATA—GENERALIZED SUMMARY.

Perceptions of the External World.			Perceptions of the Somatic Self.
Sight.	Touch.	Hearing.	
1st Week.—Passive Sensations of Automatic Movement and of			
Light.	Contact.	Auditory Jar.	Equilibrium and Organic Conditions.
2d and 3d Weeks.—Automatic hedonic control of eye,—**Fixed gazing at light.**			
4th or 5th Week.—Light sensations and eye movement sensations associated; movements suggested by visual stimulus,—**Active looking.**	Observations wanting—probably automatic hedonic control of lips and tongue.		Feeling of control over eyes and neck. Neck-control associated with equilibrium sensations,—**Head balanced.**
Sensations take on character of perceptions.	*6th to 9th Weeks.*—Contact and motor sensations of tongue associated,—**Active touch.**	*5th or 6th Week.*—Cochlear hearing established.	
	Sensations take on character of perceptions.	Sound and sight associated. (p. 120) Sensations take on character of perceptions.	
8th to 9th Weeks.—Visual and motor sensations of accommodation associated,—**Voluntary adjustment to distance.**	Automatic hedonic control of fingers. (p. 81.)		Feeling of control over tongue and lips. Touch differentiation of face and hand surfaces from alien surfaces.
	8th to 14th Weeks.—(*Roughly, 3d month.*) System of associations between touch and motor sensations of arm, hand, mouth and neck,—**Voluntary tactile-motor grasping, and carrying objects to the mouth.**	Association of sound with visual direction,—**Looking for the "source" of sounds.**	Feeling of control over arms and hands. Feeling of control over trunk, associated with equilibrium sensations.
Practice in directing eyes, and in accommodation.			
12th to 17th Weeks.—(*Roughly, 4th month.*) **Active visual exploration.** Objects delimited by the eye—plane form perceived. Rudimentary interpretations of distance and direction.	*4th Month.* **Active investigation with mouth.**	*4th Month.* Association of sound with sound-making movements,—**Sounds produced voluntarily, by hand and voice.**	*4th Month.* Feeling of control over legs. Visual aspect of hands associated with feelings of control, and of touch,—**Hands watched while moving and grasping.**
Incipient fusion of visual-motor and tactile-motor perceptions of hands and hand-movements,—**hands watched while moving and grasping**; for object of sight and object of touch slowly identified.			
5th Month. **Visually guided grasping acquired**; object of sight and object of touch completely identified.			Good somatic consciousness of hands and face.
19th Week.—Visual identification of objects as such.			
	21st Week.—**Hand investigation begins.**		
Joint hand and eye investigations. Perceptions of form, direction, distance, objective identity, all begin to take on their permanent character.			
6th Month. **Investigations actively continued.**			Good somatic consciousness of legs and feet. (p. 138.)

jects; of pain sensations with the body-surface (beginning, perhaps, in the second half-year); and of organic sensations with the body-interior.

In examining this table, one thing becomes strikingly evident. The sensations of muscular movement are not tabulated in any column by themselves; but all the developments in other departments of sense are woven in upon this pervasive movement feeling, as on the very warp of consciousness. By association and fusion with this, light sensations have become vision, contact sensations true touch. Sound acquires its location in space and its external reference by association, not with mere light sensations, but with the complex visual-motor perceptions; and the whole power to produce sounds at will rests upon their association with movement-feelings. The somatic consciousness seems to be built up by drawing the sight and touch aspects of the bodily self, the sensations of equilibrium, and finally the organic sensations, into a well-integrated association group around the feeling of muscular control. This feeling itself seems to be a fusion of pure muscular sensation with some central consciousness, probably of a representative nature; so that in the last analysis, it is with this central consciousness that the divergence of inner and outer in the reference of perceptions begins. But this last analysis takes us far into the region of introspective psychology, if not close to the verge of metaphysics.

To recapitulate, then:—

First Week.—The new-born baby lies dimly conscious of isolated sensations of light, of contact, now and then of auditory jar, and of the sensations of his own involuntary movements.

First Quarter-Year.—The light sensations, and the sensations of sucking, have a decided pleasure tone, and this intensifies the central metabolism, and so tends to maintain the motor discharge along the same channels. In this way there comes about an automatic maintenance, and later an automatic repetition, of the pleasure-giving movements: the eyes are held by lights, and recur to familiar bright spots; the fingers are kept in the mouth and sucked, or revert thither when removed.

Meanwhile, the tension thus set up at one and the same time in different centers tends to hasten the medullation of their inter-connecting neurons. Associative connections are formed, by means of which the stimulation of visual or tactile center discharges the movement that will give the associated motor sensations,—the glimpse of a bright tract comes to suggest the movements of direction and accommodation that will bring it to the point of best vision; touches on lips or hands suggest the movements of mouth, head, and hands that bring about the mouth-pleasures. Next, the representation of eye-pleasure and mouth-pleasure becomes sufficient to suggest the movements that obtain them, and objects are *sought* by the eyes and the mouth. Sounds, too, come to suggest a visual accompaniment, which the eyes seek to fixate.

Meanwhile, the infant's feeling of control over his own eyes, mouth, and neck, arms and hands, the equilibrium sensations associated with these control feelings in balancing the head, and the difference in touch feelings between his own skin-surface and foreign bodies, must have shadowed out some differentiation between external world and bodily self.

At the end of the first quarter-year, then, the infant uses his eyes well, looks about actively, and though for lack of practice and interpretation he sees objects only as undefined light and dark tracts, he locates these well in visual space. He can use hand or head movements to obtain mouth-pleasures. He associates sounds with sights, and has some perception of their direction. In some rudimentary way these experiences are felt as external, and the body-feelings, at least about the face and hands, as internal.

Second Quarter-Year.—Entering the second quarter-year, the baby rejoices in exploring with his eyes the chiaroscuro spread before him, and presently learns to trace out the outlines of objects in it, to form ideas of their distance and direction, and to identify them in their different aspects. Among other things, he observes his own hands and their movements, especially when they are laying hold of objects. The visual and tactile-motor perceptions thus slowly coalesce, the object is fixated by the eye

and reached for by the hand, is perceived as both visible and tangible.

Meanwhile, sounds and sound-making movements have become associated, and the infant produces sounds at will by hand-movements and vocal exercise.

With the increased power of investigation, he examines his own body-surface, plays with his feet, and co-ordinates the movements of arms, hands, trunk, and legs. In learning to hold the body erect in sitting, equilibrium feelings enter into the same complex with the muscular-control feelings of the trunk. The somatic consciousness is greatly extended and integrated.

At half a year old, the infant has fairly come to the use of his senses, and they give him in rough outline the same phenomenal world as ours. The bodily self from which he looks out on it is not yet explored and well defined in periphery, and the bodily consciousness is of the most unreflective, "animal" sort. The form, dimensions, and properties of external objects are scarcely known. A considerable residuum of sensation may still be felt in primitive fashion, as neither external nor internal. Nevertheless, there is a bodily self, in an external world, where visible and tangible objects are located in space of three dimensions. The whole sense apparatus (excepting that of smell) is under active mastery, and the infant has entered on a vigorous use of it to explore the world of phenomena. From this time his sense-development consists in a growing delicacy and discrimination in perceptions, and in more and more advanced interpretations and inferences.

Such a genetic process as I have inferred in all that precedes is wholly foreign to the conception that has had wide currency through Prof. James's vivid phrase and eminent authority. I cannot think that any new-born child except Minerva, full-armed from the brain of Jove, ever sprang into the midst of "a big, blooming, buzzing confusion." No other had the visual equipment for seeing it bloom, the auditory equipment for hearing it buzz, nor the associative equipment for becoming aware of confusion. Rather does the babe drift softly in among phenom-

ena, wrapped away from their impact in a dim cloud of unconsciousness, through which but the simplest and faintest gleams and echoes make their way to him. Then month after month the multiplex vision without clears itself from the background of cloud, bit by bit, everything grouped and ordered for him in the very process of coming to his consciousness—a wonder and a joy to him, and the most beautiful of all unfoldings to see.

PART III. DEVELOPMENT IN DISCRIMINATION AND INTERPRETATION.

The infant at six months old has passed fairly out of the first period of sense development. He has integrated the elementary sensory reports of phenomena and has entered upon an exploration of the world with a good co-operation of senses. But he is still far from perceiving that world as we do. The sense organs and centers are deficient in keenness and quickness of response, and the interpretation of experience by memory, comparison, discrimination, and inference, has scarcely begun.

My observations on these further processes of development (up to the close of the third year) are summarized in the following chapters and collated with those of others. It is most convenient to group the results under the different sense categories; but of course they cannot be segregated with accuracy. Developments must be classed under Sight, for instance, which were really complex products of several departments of sense and of intelligence; and so with each of the categories.

I. SIGHT.

1. CLEARNESS OF DEFINITION.

The optic nerve, according to Flechsig,[1] begins to develop from its central fibres outward, but at the time of birth is already medullated across its whole section. Whether the retina is in an equally functional condition at this time, and capable of forming a sharp image, we have not (so far as I know) any anatomical knowledge. In any case, whatever the retinal reaction, a clearly defined image in consciousness is impossible until the infant is able to fixate it, and to trace its outlines with the fovea. I have already given my reasons for thinking that this happens about the fourth month (p. 69, *et seq.*).

This stage once attained, the behavior of the child indicates

[1] Gehirn und Seele, p. 53.

an increasing exactness in the definition of images. The rapid growth of recognition shows that objects of vision are becoming differentiated and discriminated. There is a progressive decrease in the *size* of objects that are attended to. Up to the latter part of the fifth month, no object under an inch diameter was noticed and reached for by my niece; in the sixth month, flies on the pane; and in the ninth, as she crept about, every scrap and shred, down to a pinhead size; once a single hair.[2]

A still better test of fine definition is the recognition of small pictures of known objects, and of printed letters, which was surprisingly good in the 12th and 13th months, the simplest form, the letter o, being spontaneously sought out and recognized down to lower-case bourgeois size (o), in the midst of context (see under Form, pp. 172–3, below; also I, pp. 58 and 73–4). In the 14th month, faces down to one-fourth of an inch in diameter were recognized in photographs, which must have involved some discrimination of minute differences of feature.[3]

In the early months of the second year, then, the child's eye is scarcely inferior to that of the adult in the power of refined definition; and the mind is capable of making fine discriminations and recognitions on the basis of minute visual differences.[4]

2. PROMPTNESS OF DIRECTION AND ACCOMMODATION.

The first voluntary movements of the eye are noticeably slow. In testing the ability to follow a moving object, one must draw

[2] Mrs. McLeish notes that her daughter, when first creeping, 10th and 11th months, picked up the most minute objects. Mrs. Hall's boy in the 9th month, Preyer's in the 11th, was absorbed in examining a single hair.

[3] Professor Sully, citing this, says that he noticed the same fineness of perception in his boy. Mrs. Daniels's daughter recognized photographs in the 15th month, Mrs. Wood's boy at 16 months. Professor Preyer did not note recognition of photographs and other pictures till the beginning of the third year, but I feel sure this must have been for lack of earlier tests. See also the citations from Mrs. Tilley, Mrs. Catterall and Mr. Cooley, under the head of Form, pp. 173–4, note 36.

[4] I suspect that good *illumination* is more necessary to the child's visual definition than to ours. As late as the 20th month, my niece's recognition of persons was decidedly affected in a room somewhat under-lighted (I, p. 16). The same thing has been noticed in color perception (I, p. 46, and Preyer, *op. cit.*, p. 20).

it along at a snail's pace, or the baby's eye loses hold of it. By the 15th week, my niece's eyes followed persons constantly as they moved about at their ordinary pace.[5] In the 23d week, she began to look after falling objects,[6] but I do not know how accurately she kept them in focus. In the 24th week, she followed the movements of our hands persistently, especially from plate to mouth, at the table.[7] In the 7th month she watched the flight of birds.[8]

These observations, with the few from other records given in foot-notes, do not discriminate clearly between advance in quickness of direction and of accommodation; and they give but rough measurement of the actual rate of eye-movement. I know of no attempt to measure the rate accurately, except one observation of Preyer's,—viz., that his son once, in the 15th week, followed the motion of a pendulum making forty complete oscillations to the minute,—a surprisingly quick eye-movement, and out of keeping with the child's own habit.[9] Darwin says that his baby, in the 8th month, could not follow an object well if it swung "at all rapidly."

3. COLOR VISION.

It may be accepted as a settled fact that the newborn infant sees no color (pp. 23–4). The question of the development of color sensations is a perplexing one. Observers have been occu-

[5] Mrs. Saunders, 11th week; Mrs. St. John and Miss Shinn (nephew), 12th week; Preyer, 14th week; Mrs. Hall, 15th week; Mrs. Conard, 17th.

[6] Mrs. Tilley (first boy), 18th week; Miss Shinn (nephew), 22d week; Mrs. Helliwell, 26th week; Mrs. Cook, about 28th week ("6 to 7 months"); Mrs. Catterall, 33d week; Mrs. Tilley (second boy), 35th week; Preyer, 47th week. The movement is important as giving space measurement downward, rather than for practice in quick accommodation.

[7] Sigismund, 19th week. Mrs. Tilley saw a somewhat similar movement in the 17th week.

[8] Preyer's son looked after a bird flying by, in the 7th month; my nephew in the 6th.

[9] Professor Preyer says the movement was executed "with machine-like regularity." It is possible that it was not a voluntary movement, but a sort of survival of the old following reflex, of which indications are to be found in the newborn child (p. 25). Sigismund's son followed a pendulum in the 19th week; nothing is recorded of the rate of vibration or accuracy of following.

pied with the secondary question of the *order of emergence* of well discriminated color perceptions, and not with the preliminary question of the beginning of color vision itself. And again, in such observations as we do have on the subject, scarcely any account has been taken of the difficulty in distinguishing reactions to color from reactions to brightness. Indeed, early observations (including Professor Preyer's) failed to consider seriously even the objective illumination of the colored surface as affecting the reaction.

We have three questions to consider: (1) How long does the newborn condition of color-blindness last? (2) By what steps does the child emerge from it? (3) To what advancement in color perception does he arrive within the time under consideration (the first three years)? And these questions have a certain rough correspondence to three periods of development in the child. The first is that in which we can find no evidence of any recognition or discrimination of colors, and must give our attention to the question whether the child really *sees* them at all, or whether his reactions to colored surfaces are not in fact merely reactions to light. This period lasts for about a year and a quarter. In the second period, which we may look for somewhere toward the middle of the second year, signs of the formation of definite color concepts should become apparent to us, if they exist, through the dawning ability to understand or even to use color names, or through evidence of color associations and recognitions. In the third period, which may begin in the latter part of the second year, and certainly by the third year, the child is found more or less capable of all the color concepts, and the observer has only to ascertain how far the color vision is identical with that of the adult, or how far it still shows significant limitations.

First Period: Light and Color.—From the fourth week, in my niece's case, the eyes began to dwell on colored objects, and from the third month, demonstrations of joy and desire at sight of them were recorded (I, pp. 25–29). Yet the instances were comparatively rare, and usually occurred under such conditions that

the baby's interest might have been due to the reflection of light by the colored surface, or to some strong chiaroscuro produced by its contrast with the background, or to its motion. In the case of yellow flowers (and perhaps of orange ones in a less degree) the cumulative evidence of the child's behavior made it hard to doubt that something about the color itself did consistently attract her; but here we have to consider the great inherent brightness of yellow.

The "warm" or long-wave colors seemed to be preferred always to the short-wave ones,—yellow coming first, next orange and red, then pink, while blue and violet were scarcely noticed, green still less. This order certainly suggests a double standard of preference: first, the degree of inherent brightness; second, the degree of redness. But a surface of cold color in strong objective illumination was always preferred to a surface of warm color less lighted; and in general, white objects, and still more, glittering ones, excited more decided reactions than color. When I attempted some tests, at the end of the sixth month, by dangling colored ribbons before the child, she grasped regularly at the one that received the strongest light from the window; and when we made the objective illumination equal, she turned from one ribbon to the other with equal joy. It is entirely possible that had I made the whole set of them gray, matched to the respective brightness of the colors, I might have had exactly the same reactions.

The observations of others accord very well with my own. It has been customary to fix the appearance of color vision about the end of the third week, on the strength of Professor Preyer's observation of the 23d day (*op. cit.*, p. 6). But the object to which Preyer's child reacted was a rose-colored curtain ***brightly lighted by the sun.*** We have no evidence that the child would not have shown just as much pleasure over a gray curtain, equally lighted. Professor Preyer himself thought it possible that brightness, not color, was the stimulus. In all the notes before me, I find but a single instance of attention to color within the first half-year where the interest seems at all certain to have been due to chro-

matic perceptions.[10] Notes of attention to colored dresses, ribbons, flowers, etc., occur in most records; but the possible influence of high light, or of sharp contrast of light and dark, is never eliminated. In some cases it is evident that there was such an influence: it is noticeable how often it was a white dressing-sack with red spots, cerise roses on a black hat, a red and blue jumping-jack, a striped ribbon, that attracted attention,—objects that to the color-blind would present strong contrasts of light and dark. Indeed, black and white objects are sometimes expressly mentioned as attracting attention, just as the light and dark contrasting colors do.[11]

Meanwhile, the notices of joy in *light* are numerous and emphatic. Especially moving and changing lights, such as the reflection of sunlight from a shaken glass of water, the flickering lights and shades of wind-stirred foliage, delight the baby.[11a]

[10] Mrs. McLeish's daughter, on the 33d day, was tested with Prang's large color sheets, and gazed intently at the red for over 3 minutes, making movements with her arms; the yellow she had looked at only a second or two, with an expression of surprise. The objective illumination of the color sheets may have accounted for the interest in red; but the *preference* of red over yellow, with its much higher light content, would seem evidence of color seeing if the observation were not so entirely unsupported. Even in the case of this same little girl there was no decisive confirmation of it before the 9th month.

[11] When we notice a child's joy over a hedge full of blossom, a cluster of berries, etc., we should take into account the profuse high lights and contrasting shadows of such groups of objects.

[11a] There is nothing in which all records agree so decisively as in dwelling on the interest and pleasure derived in the early months from the sight of (*a*) brightness, or strong chiaroscuro, (*b*) of moving and vibrating objects, and (*c*) of the human face. "Things which appeared to give him repeated and endless enjoyment of a quiet sort," reports Sully (*op. cit.*, p. 409), "were the play of sunlight and of shadow on the walls of his room, the reflection of the shooting fire-flame sent back by the window-pane or the glass covering of a picture, the swaying of trees, and the like." So, too, Preyer (*op. cit.*, p. 46): "Such strong impressions of light produced gayety, just as swinging objects did. The 62d day, *e. g.*, the child looked for almost half an hour at a swinging lamp, hanging from the ceiling, with continuous utterances of pleasure. . . . His pleasure manifested itself by movements of the arms, and by sounds such as are made by a child only when he is pleasurably excited; his interest was shown by an unvarying gaze. The day before, the child had looked upon the friendly face of his mother for some minutes, and then given a cry of joy. The face of his

With the second half-year, there is more evidence of real color vision. I find in one case the same observation as my own, of

father, too, became at this time, before the 10th week, an occasion of gayety."—Darwin says that the smiles of his children (7th week) arose chiefly when looking at their mother (*op. cit.*, p. 35).—Mrs. Hall's boy in the 3d week was "more attracted by persons than any other object, probably on account of their motion"; in the 5th week, he watched a swinging ball for a half hour, laughing at intervals as he looked, and his first continued laugh was as he watched this swinging ball, two weeks later. In the 17th week he became restless and fretful when his carriage was turned to face a stone wall, but was happy for an hour when it faced the wind-moved leaves and branches.—Mrs. Moore's child, in the 9th week, liked to watch silent movements of the lips and tongue, an empty chair rocking, the moving leaves outside the window. In the 10th week, while crying, he was laid upon a sofa, above which a gas jet was burning. The moment he saw the light, his crying ceased, and his whole body began to move in excitement, and the interest and excitement were maintained without interruption for half an hour." In the 12th week, most of his waking minutes were spent in the bassinet on a porch, watching the trees moving in the wind against the sky. Thus occupied, he often lay for an hour, quiet except for the movement that accompanied deep interest. Mrs. McLeish's daughter, in the 9th week, "followed with great interest and apparent pleasure the reflection of the sunlight flashed upon the ceiling from a small mirror; followed it everywhere, even when doing so necessitated her turning her head into most difficult positions, and a week later she was kept quiet in the mornings as she lay on the bed by a reflection of the sunlight on the ceiling; she was interested for a half hour in some kindergarten balls fastened over her head and swinging. By the 11th week, these swinging balls had become a source of great pleasure to her. It seemed to be the motion that interested her."—Mrs. Cooley's MS. record says, "The sight of moving things always interested more than color or brightness. He watched the blowing leaves of the trees as he lay in his hammock, from the 8th week all through the summer. Shadows on the ground were a great joy also."—Sigismund says, "There is nothing that children smile at more regularly and frequently than their reflection, or other human faces."

So I might multiply quotations page after page. The sparkling Christmas tree, gilded picture frames reflecting the light, brass knobs on a bed, polished door panels, the flash of the mother's diamond ring, the dark braid of hair lying on her white gown, the contrasting stripes or figures of her sacque, or of the wall-paper, the older child frolicking close by, the face of friend or stranger,—entry after entry, in all records, is taken up with the pleasure and interest excited by such sights.

"Luminosity, brightness in its higher intensities, whether the bright rays reach the eye directly or are reflected from a lustrous surface, this makes the first gladness of the eye, as it remains a chief source of the gladness of life" (Sully, *op. cit.*, p. 300). The strong stimulus given by light and dark contrast, too, appearing as it does by the 3d, or even the

an interest and desire excited by yellow, too consistent to be set aside;[12] in another, of the same general preference for the long-wave colors that my niece showed;[13] in the case of at least one child, repeated and distinct choice of red.[14] Yet with

2d week, long before "apperceptive illusion" is to be thought of (I, p. 10; see also *op. cit.*, Alcott, p. 8, and Mrs. Hall, p. 458), must be credited to simple physiological reasons, as maintained by Hering. The stimulating effect of motion would seem to be sufficiently accounted for by the number and rapidity of the discharges in visual cells caused by the movement of the image over different parts of the retina. When brightness and motion are united, as in the flickering lights and shades of blowing foliage, or of the reflected light from moving water, the joy is enhanced. This union of changing high lights with motion, as people nod, smile, speak, and move their eyes, is no doubt the first cause of the fascination of the human face, before the baby has begun to associate it with the voice, and with the sundry ministrations of friends.

[12] "By the 27th week he manifested a decided preference for yellow, stretching out his hands for anything of that color—lemons, oranges, sunflowers, and even the butter on the table." Mrs. Hall, *op. cit.*, p. 460.

[13] Mrs. McLeish was satisfied that from the 5th month on her little girl showed consistent preference for red and yellow, with attention also to orange and pink—an exact confirmation of my own conclusions. Mrs. McLeish gives one instance of what seems a clear preference of red over blue, in the 9th month: "Tried to crawl to the red ribbon, and reached out her hands for it. When the positions were reversed, she still showed a preference for red." *Op. cit.*, p. 113.

[14] Mrs. Tilley, whose record is exceptionally candid and cautious in interpretation, and who takes the consideration of objective illumination more carefully into account than most observers, noticed from the 6th month a marked interest in red objects, which she tested pretty conclusively in the 9th month. Sundry dull-colored objects were strewn on a lounge, and among them a red-lined jacket, and a hat with red velvet trimming. The red objects were at once reached for, one after the other. In several careful little tests during the 9th month, Mrs. Tilley obtained the same result, while the spontaneous instances of striking interest in red continued throughout the following months. In the 14th month, the child repeatedly selected a red ball from among many green ones.

It is true that the differences of inherent brightness were not eliminated in any of Mrs. Tilley's tests. A red-lined jacket among a number of dull-colored garments, if these were of light grey or tan tints, or a red ball among bright green ones, would have stood out to a color-blind person as a distinctly *darker* gray, and even though less attractive in itself, might have been chosen because it drew attention by its singularity. But the objection seems to me pedantic, in view of the number and consistency of the red preferences noted by Mrs. Tilley. It is out of the question that red should have been every time, in a period of months, favored by this or that condition of illumination or contrast.

these exceptions, I find still only the same indecisive notices of color reactions as in the first half-year. Recognitions and discriminations depending on color, such as occur in the second year (p. 161), are conspicuously wanting, although such associations are by this time evident in connection with form, and with sound, touch, and taste. In some cases, indifference to color, or at least, the absence of decisive indications of color sensibility, is expressly mentioned by the observer.[15]

Two series of formal experiments concerning the color sense in the second half-year are known to me:[15a] Professor Baldwin's, and a series made by Mrs. Tyler, of Denver, Colorado, and still unpublished.

Professor Baldwin's included 217 separate tests, in which four colors, red, blue, green and brown were used, besides white, and

On the other hand, a single instance of apparent discrimination between green and blue given by Mrs. Tilley (8th month) may very likely have been mere brightness discrimination. The child showed that he recognized a green waist as novel, after he had been accustomed to seeing his mother in a blue one. The colors, fairly alike in saturation (as Mrs. Tilley carefully notes), would differ enough in their place in the "black-white" series to give the child a certain feeling of change; a child's eye is quick for alterations in his mother's apparel, and just the same reaction might have been seen had a darker gray waist been exchanged for a lighter gray.

[15] So Mrs. Daniels, in the case of her son. Mrs. Moore says that her son "did not give conclusive proof of the ability to recognize colors" till the second year. Mr. Cooley says of his child: "Color, as such, seemed not to attract him at all. The brightest reds and yellows had no perceptible effect on him, unless the object moved. Then he showed vague signs of excitement; but this was as great with a white or gray object as with a bright one. When he began to use his hands, accident, or proximity, or some movement, seemed the determining factor in every choice. When he understood speech, red, blue, etc., always seemed at first to mean to him shape, size, or some such peculiarity. That is, when shown a red block, and asked to give a red block, he would choose one of the same kind, but of any color, and when this was rejected, seemed utterly at a loss. We really were inclined to suspect color-blindness." Yet this child showed excellent color discrimination by 3 years old. My nephew, now 9 months old, has always shown the same indifference to color.

With the exception of Mrs. Daniels's and Mrs. McLeish's daughters, every child reported to me (and I have asked the question in many cases outside of the score of records in my hands) has liked uncolored pictures quite as well as colored, or even better, in the first and second years.

[15a] Besides a series now in progress, with my nephew.

an ordinary newspaper ("chosen as a relatively neutral object, which would have no color value, and no association to the infant"). Neither orange, yellow, nor gray was used, and the question of inherent brightness was not taken into account at all. The tests began at 9 months old, and extended over six months. Of the 217 separate tests, 106 were given with the newspaper, 100 with the colors, and 11 with white. The tests with each individual color were too few to bring out any decided result as to the infant's color preferences. But two results do stand out very clearly: although the conditions of the experiment discriminated against white, and against the newspaper surface,[16]

[16] Professor Baldwin's are the first systematic tests (and so far the only published ones) to ascertain the real state of color seeing before the age of speech; and they point out conclusively the general method that all observers must use, to get any further light on the problem. These facts, and the eminent rank of the observer as a psychologist, have given them great weight in all discussions of the subject. Therefore I cannot pass them by in my own discussion without explaining why I am able to utilize them so slightly.

In the first place, where the very point at issue is to ascertain whether the child reacts to brightness or to color, any experiment is vitiated from the outset which fails to consider the question of inherent brightness. Where colors of standard saturation are not used, they might easily exchange places in the brightness scale, and yet seem on casual selection to be of "about equal objective intensity," and "relatively evident spectral purity." Green can take in a good deal of gray before it seems to have lost its purity; blue a good deal of green. I cannot help thinking that the red of any ordinary commercial blotting paper would be deficient in the purity and intensity of the reds that do attract babies at this early stage. It is evident in Mrs. Tyler's experiments that a defect in the purity and saturation of the yellow used was enough to throw it back from a high place in the baby's choice to the very lowest. If colors are not seen at all at this stage, or if they are seen as if in very weak solutions, it is evident that Professor Baldwin may have spoiled his experiment completely for the relative values of red and blue by using a dull red; blue may have been reached for merely as a medium gray, valued as much as the dull red. Mrs. Tyler's experiments showed that a medium gray ranked well with most of the colors in attractiveness. Again, the omission of yellow, orange, pink, and gray from the tests crippled them on precisely the points where we wish information; while "brown" is really a valueless color in such an experiment unless we know the composition of the brown,—the name is the loosest in our color vocabulary.

In the second place, so small a number of trials with each individual color cannot establish any real order of preference, unless the child's choices varied strikingly and consistently. Even if Professor Baldwin's blue and

the newspaper was grasped at in 76 per cent. of the tests, the colors in but 71 per cent.; while the percentage for white, 78, was as high as that for the highest color. With a rectification of the conditions, the superior attractiveness of the white surface, and of the black and white of the newspaper, over any color, becomes quite striking.[16]

In 1901, Mrs. Emma Teller Tyler (B. S., Wellesley, '89), repeated Baldwin's tests, using, however, the six spectrum colors, matched to those of Bradley's charts, besides black, white, brown, and three grays. The material was grosgrain ribbon, the lusterless side being used. In a supplementary series of experiments, small balls, in knitted covers, were used. The two series, beginning when the baby was nine months old, extended over a period of about four and a half months, and included 518 single

red had certainly occupied their true relative places in the brightness scale, it would be absurd to set it down as an ascertained datum for color discussion that his child preferred blue, when the difference between her red and blue choices netted just about one more grasp at the blue than at the red, in a period of six months!—and when neither red nor blue was to any appreciable extent more attractive than an old newspaper, at that.

Again, Professor Baldwin assumes that the *distance* at which the child will reach for an object will be the measure of its attractiveness, and this again of the intensity of the sensation, without taking it into account that the surfaces suffer unequally by increase of distance (especially if projected against a background which affects them)—an influence which plainly did come into play. Still again, he has failed to notice that his dice were in one respect actually loaded in the interest of the colors, and of blue especially, as against the newspaper, and the white paper. About one fourth of the total number of tests with these latter papers were made at the difficult reaching distance of 15 inches (a distance at which the child refused to try at all, nine times out of ten); while only about one sixth of those with red, and not as many as one seventh of those with blue, were made at this distance. And conversely, one sixth of all the blue tests and one ninth of the red ones, were made at the short distances at which grasping was invariable—and *not one* of those with the white paper, or the newspaper! Total percentages based upon such inequities are valueless. By eliminating the extreme columns, where the inequities occur, one may see from Professor Baldwin's data that the white blotting paper and the old newspaper were decidedly more attractive than any color (were, in fact, grasped all but invariably); that the difference between red and blue was inappreciable (about a quarter of a grasp, in six months); and that brown and green were really discriminated against, but how much we can scarcely say, in so small a number of tests.

experiments; but as Mrs. Tyler used a larger number of colors than Baldwin, her percentages for each color are not based on figures so much larger than his as might appear (Baldwin, 11 to 35 tests to a color; Mrs. Tyler, 17 to 80). All conditions of objective illumination, of fatigue or variation of physical condition in the subject, of the influence of preference for right or left hand, of reaching distance, etc., are carefully attended to and recorded. The tests were divided between the strict Baldwin method of offering the colors singly, and recording the ratio of "acceptances," and that of offering them in pairs for comparison and choice. Sometimes the balls were placed in a row on the floor, and the child was allowed to creep to them and select. In such cases, the order of arrangement was constantly changed, so as to favor no color by position.

Mrs. Tyler's experiments are the fullest and most careful yet reported.[17] Yet they leave us still without conclusive evidence as to the condition of the color perceptions at a year old. The strongest impression they left in the mind of the observer herself was that of the child's indifference to colors. He reached for them when they were placed before him, but was consistently interested in the apparatus more than in the colors. When only one color was offered at a time, he took each one that was offered till he grew tired, then refused all; when two were offered he sometimes took regularly the one at the right hand, sometimes regularly the one at the left hand (apparently finding no sufficient stimulus in the color to inhibit the momentary habit suggestion); again, he is recorded as seizing both at once. The total percentage of "acceptances" (or more correctly, preferences) of colors was 58; of members of the black-white series as against colors, 65,—an actual superiority in the black-white impressions

[17] There is one possible source of serious error in considering Mrs. Tyler's results. In the pairing of colors, a color might be given an accidental advantage by being paired unduly often with one less attractive than itself, and *vice versa*. Mrs. Tyler's combinations were so many, and so well distributed, that in the cases where forty or fifty tests to a color were made, I think errors of this sort canceled out fairly well; but where the tests were few, it is necessary to go back and study the detailed experiments (which are fully reported) to see whether the ribbon in question had its fair chance and no more.

over the color ones, due to the fact that white was in higher favor than any color, while the grays on the whole stood high. Even black stood about as high in favor as blue, and higher than violet.

In the individual choices, there was little to establish clear color preferences. In the ball experiments, Mrs. Tyler was unable to secure a good yellow, and the one used (weak in saturation, and tending toward green) was rejected by the baby even more decidedly than black, though in the ribbon tests, where a good yellow was used, it was among the favored colors. A deep, reddish brown, (falling between the red and orange in the weak-light spectrum) seemed to be preferred to all other colors in the ribbon tests; but the number of experiments with this color was few (17), and I thought them inconclusive, for the reason mentioned in note 17. If we set them aside, and also those for yellow in which a weak and impure tone was used, we get from the tests the usual net result,—red, yellow, and orange the most favored colors, but neither liked as well as white, nor showing any superiority in attractiveness to mere gray.

One item of significance is that in the ball tests, but not in the ribbon tests, orange attracted the child conspicuously,—the only clear and persistent preference shown in all the tests, surpassing even the preference for white. Mrs. Tyler suggests that association with the fruit (with which he often played) accounts for this discrepancy between the two sets of tests. If so, we have here the single instance of association by color that I can find, earlier than the middle of the second year.

Add to these two formal sets of experiments some informal ones that were tried by Mrs. Sharp with her baby in the seventh month, when he consistently dropped red, blue, or yellow ribbons to grasp at either scarlet or gray, but preferred the scarlet as consistently to the gray,—and we have gathered all the evidence that I know concerning color seeing in the first year, and the earliest months of the second year. Three conclusions from it are irresistible: (1) Color interest is weak, and colored objects are preferred to gray ones in far less degree than is popularly supposed, if at all; (2) Brightness, on the contrary, is always attrac-

tive; (3) Red (including pink), yellow, and orange are overwhelmingly indicated as the colors that attract most.[18]

A theory of color vision in the infant formulates itself quite plausibly from these conclusions, as follows: For the first half-year, at least,—perhaps far on into the second half-year, in some cases,—the child receives only light sensations, not chromatic ones. Surfaces, therefore, attract in proportion to their brightness, white first, then yellow. Sometime in the second half-year, sensations of red begin to be received, which contend with those of the primitive black-white scale for the baby's attention, in the order red, orange, pink (pale red). If these red perceptions are very feeble, or even lacking altogether, the baby will seem to prefer yellow, though seeing it, in fact, only as a light gray; if they are better developed, red objects will attract most. At a year old, therefore, the child would see the world in two color series, the black-white series, running through all degrees of gray; and the red series, including all degrees of red.

The theory fits the facts well, except for one consideration; and that is, the uniform indifference to *green*. If yellow is valued for its brightness only, it is not comprehensible why green, so close to yellow in inherent brightness, should fall so decisively below it in attractiveness.[18a] Professor Kinnaman's monkeys

[18] I do not ignore Professor Baldwin's testimony to blue as a favored color; but I have already given my reasons for thinking it inconclusive, and it stands absolutely alone, as far as this early period is concerned. I do ignore many general statements that this or that was the "favorite color" of some baby. Casual observation is easily misled in such a matter. A baby's interest in an object is often attributed to color, when the exclusion of other interesting traits—form, motion, use—or of direct suggestion, would show that color had nothing to do with it.

[18a] It is possible that green has not a fair chance in the favor of babies, because the greens used in dress and furniture are never pure, bright greens; while the greens of foliage contain a great deal of gray. Still, Mrs. Tyler's tests with standard colors ranked green decidedly below yellow. See also note 31, p. 169.

It should be added that it is not really established that white, apart from strong objective illumination, is consistently preferred to yellow in the first year. If it should be shown that any baby of this age did in fact prefer yellow to white, we must conclude that it is already valued for its yellowness, not its brightness alone.

could not discern brightness differences as slight as that between yellow and green, when the grays were not re-enforced by color quality.[18b] We are obliged to think, therefore, that some color is seen in yellow,—probably but a faint infusion, since even in the third year, when all the color concepts are fairly clear, there appears a tendency to confuse yellow with white (p. 168). There is, then, a double standard of preference, but it is not so much a brightness standard and a redness standard, as a brightness standard and a "warmth" standard. That vividness, that "energy of decomposition," which we ourselves feel in the long-wave colors when we call them "warm," seems to be that which attracts the infant, and competes with pure light in his preference. All color impressions seem to be feeble at this period, and it is not improbable that something in the impact of the long waves is able to discharge a chemical process that cannot yet be accomplished by the short waves.[18c] If this is so, then blue, green, and violet are seen only as gray; red, orange, and pink attract by true color quality; and yellow by brightness, enhanced by a faint infusion of color.

Second Period: Dawn of Conscious Color Discrimination.— In the first quarter of the second year, my niece's behavior toward color was just as in the first year,—the same interest in light and shade, the same comparative indifference, or even defect of perception, toward color. The first evidence of speech carried on the same indication. The child was at the time picking up the meanings of words with rapidity and ease. *Light* and *dark* (as a light or dark room) were readily understood in the 14th month, and before the end of the month the child herself began to use *dark,* applying it, together with *black,* to any ink-blot,

[18b] Mental Life of Rhesus Monkeys in Captivity. By A. J. Kinnaman. American Journal of Psychology, Vol. XIII, pp. 98–148, 173–218.

[18c] Preyer's theory of color vision—that it is an exalted development of the heat sense, and develops regularly from sensitiveness to those vibrations that are nearest the heat-wave in rate to those that are furthest—has, I believe, no acceptance whatever with physicists. Romanes, however, approaching it from a biological point of view, thinks it plausible, when we remember that visual sense probably arose by elaboration of temperature nerve endings (Mental Development in Man, pp. 98–103).

smut, dirt-streak, or the like. Color names, on the contrary, she seemed quite unable to understand until late in the 16th month (I, pp. 29–30).[18d]

At this date, a great change appeared (I, pp. 31–35). She began suddenly to name *red,* exclaiming, and pointing with zeal to red objects. A month later, in another wave of spontaneous interest, she began to name *yellow* and *blue.* The colors were recognized in various degrees of purity and saturation,—a sure evidence that they were distinguished by their chromatic quality. The child also caught readily the meaning of the question, "What color?"—knew, that is, what trait of the object was to be separated out and named. In the following month (18th) I noticed for the first time instances of memory and comparison by means of color.[18e] And now appeared, at 18 months old, such interest in colors, such spontaneous exercises in naming them, (as in pulling out books, one after another, calling the colors), and such correctness of perception, that I began formal color tests; with the result that the child proved perfectly able to discriminate and name all the spectrum colors before she was 22 months old (I, pp. 31–32, 34–54).

We seem here to have detected a period in which the child was capable of the concept *black,* but not yet of any color concept, followed by a period in which she was capable of the color concept

[18d] My published "Notes," in the pages cited, give the impression that it was quite as impossible for the child to distinguish *white* from any color name as the color names from each other. My more detailed original notes show that this was not quite so; there was a feeble ability to distinguish an object by the description "white," but absolutely none to understand one color name as distinguished from another.

[18e] As, for instance, when the child cried, "Lady!" at sight of a piece of red cloth, some weeks after a lady in a red dress had visited the house (I, p. 34). So Mrs. Tilley's boy, at 17 months, cried, "Custard!" at sight of something yellow, and Professor Sully's in the 19th month, "Apple!" at sight of a patch of reddish color (*op. cit.,* p. 422). Such associations, had they existed, could have been expressed in language some months earlier than this; and even before that was possible, the child would have been likely to show them in some way, as he shows easily enough that a black and white outline picture suggests the cat, or the sound "bonnet" the corresponding object. The one hint of any association of the sort that I find earlier than about the beginning of the 18th month, is that indicated by the fondness of Mrs. Tyler's boy for an orange-colored ball (p. 158).

red, but no other, and again by a period in which all the color concepts became possible. If this was a typical case (I have not the comparative data to judge how far it may be so)[18f] we have in the color concepts of a child at about a year and a half old a striking parallel between ontogeny and phylogeny. There is the same expressed consciousness of black and white, shine and shade, preceding any color words; the same early emergence of red into linguistic consciousness, the same delay in naming other colors.

How are we to interpret this curious succession of stages in color naming? We can hardly doubt that red, orange, and yellow, at least, were *seen* for months before; why is red now discovered, as it were, with sudden interest and pleasure? and thereafter, the other colors? Can we consider the wave of attention and discrimination as due only to the new power to *name* the perceptions?—a power that is always intensely interesting to

[18f] Mrs. Hall's boy noticed and named *black* from the 13th month, and at the date when the record closes, in the 17th month, had not been able to use any color word intelligently. I find no record except my own of the real use of color names before the 22d month; in some cases a few are included in vocabularies taken at two years old, but the date and order of their appearance is not given. Toward the end of the second year, and in the third, there is reason to think, a child fairly well advanced in speech is capable of understanding and learning almost any color name, and a hundred chances of suggestion may determine which one he will pick up first; so that by this period the order of appearance ceases to give us much clue to the order of emergence of the concepts. For what it is worth, I give the instances of color words used before the end of the second year in which I can determine the order of appearance. Mrs. Moore's son used *red* only, before the third year; one of the children reported by Professor and Mrs. Gale used *pink* (light red) in the 23d month; Mrs. Tilley's older boy used *blue* in the 22d month, and her younger son at the same age mastered *red* and *blue* somewhat imperfectly, by teaching. Of these two brothers, the elder in the 22d month recognized pieces of green and blue cloth as matching well-known garments, and the younger, between the 19th and the 24th months, learned to discriminate most of the colors, somewhat reluctantly. Mrs. Moore's son "showed that he recognized" several colors (21st–23d months), in the order pink, yellow, black, blue, red, light brown and gray; no detail is given of the observation, however; the names were not used, unless *red.* Mrs. Conard's boy, in the 22d month, recognized pieces of green gingham as matching his apron, but did not name colors till the 3d year. It is evident from these instances that there was no constant relation between the order of development in color recognitions and in color naming.

the child, and that leads him often to discriminating observation of things he had scarcely noticed before? It would really beg the question to say so; why should the power to name the perceptions be delayed to this period, when other concepts, which seem to us much more abstract and less obvious, are coming rapidly to expression?

Grant Allen, speaking of the same problem in ethnology, says color names appear late because they are adjectives, and require an advanced mental process in analyzing out the attributes of an object and naming them, apart from the object itself. We must not be pedantic with a baby's parts of speech: it is convenient to speak of them as nouns, and verbs, and adjectives, but we cannot really force them under our grammatical categories. That which interests the baby (whether it be a group of traits fused into a single concept, as *kitty,* or a single striking trait, as *dark,* or *hot*), calls to his lips as a mere ejaculation the articulate sound that has become associated with it.[19] And I cannot see that there would have been any more advanced analysis in pointing at a red ribbon, or blot of red ink, and crying, "Red!" than in pointing at a blot of black ink, or a coal smutch, and crying, "Black!" Yet the *red* identification seemed impossible to my niece for two months after the *black* one was easy; to Mrs. Hall's boy for at least four months. Both these children, moreover, used several other descriptive adjectives before color names appeared; and while no other record corroborates mine as Mrs. Hall's does with regard to the early appearance of *black* (*dark,* however, often appears early), all the vocabularies in my hands show that other adjectives did precede those of color, by a considerable interval,—two or three months, even up to eight months, in all cases where I can fix the dates.[20] Color fails some-

[19] Notice, for instance, how often in the baby's "nouns" a single salient trait only is really named; so that "chemin de fer," for instance, means a railway engine, a coffee-pot, anything that hisses and smokes and makes a noise, and "star" anything bright or shining (Sully, *op. cit.,* p. 163).

[20] *Op. cit.,* Sully, pp. 427–8, 437; Mrs. Moore, pp. 141–3; Mrs. Hall, pp. 604–6, 461; Dr. Wilhelm Ament, Entwicklung von Sprechen und Denken beim Kinde (Leipzig, 1899), pp. 109–117.—M. C. and H. Gale, The Vocabularies of Three Children of One Family, to Two and a Half

how to supply a trait salient and interesting enough to call out the earliest adjective-making tendency,—temperature, size, taste, all take precedence, and this even in cases where special effort had been made to call attention to color differences. And the other colors still fail, after red has "risen to verbal consciousness." The fact that red pushes so far to the front of yellow in nomenclature (both with the child and in philological history) goes to confirm the suspicion that it is chiefly for its light-strength that yellow is valued, and that its chromatic quality, though enhancing the pleasure, is not very clearly felt.

For the short-wave colors, I cannot find conclusive evidence that any baby, up to the 18th month, can even see them. Yet as a matter of fact, whether these colors are or are not seen at all in the first year, I have no doubt that for some time before they are noticed and named there has been some perception of them. The real condition of color vision about the middle of the second year is probably very much that which is formulated by Magnus, in speaking of "Naturvölker" whose color-seeing has been well investigated:[21] "The *range* of color sense is invariably the same. The seven colors are everywhere distinguished";[22] "A

Years of Age (Minneapolis, 1900), pp. 90–91.—MSS. of Mrs. Tilley, Mrs. St. John, Mrs. Hoyt, Mrs. Conard, and of Mrs. Bertha de Laguna Price (B.A., M.A., Stanford, '94, '97). Mrs. Price's older daughter used at least 17 descriptive adjectives intelligently at two years old, but echoed color words without meaning; and Professor and Mrs. Gale report 36 descriptive adjectives in their youngest child's vocabulary, before the first color word. Mrs. Moore says, "Color adjectives were the last to be added" (*op. cit.*, p. 128).

Professor Sully notes, truly enough, that the first adjectives refer "rather to the effect of things on the child's feeling than to their inherent qualities,"—as *hot, cold, wet, pretty, good,* which take precedence in most lists. But there is no lack in most lists of such objective words, also, as *black, big, empty, clean, dead.* And, as I have just remarked, many of a baby's nouns are quite as truly adjectives as a color name would be.

[21] Ueber Ethnologische Untersuchungen des Farbensinns.

[22] Dr. Kinnaman has carried the proof of complete color-seeing even further back, putting it beyond doubt that monkeys can see all the colors well enough when there is anything to be gained by it. Yet there is evidently some difference between the monkey's color-seeing and that of man, for with both his monkeys green was the color most securely identified (*op. cit.*, p. 145).

race may have good color discrimination, and miserable color vocabulary, except for red"; "They have all the color sensations, yet there is a variation in the intensity with which they are felt; some parts of the spectrum are felt strongly, others seem to be felt as alike, or neglected, and these are always the short-wave rays; red, up to yellow, is always strongly felt."

Third Period: Color Development to the End of the Third Year.—From the middle of the second year up to the end of the third falls a period in which careful tests have always found the child able to discriminate all the color impressions, about as well as any grown person. Some children pick up a correct use of color words quite spontaneously at this time, like Binet's older daughter, and Mrs. Tilley's older son; others, like Preyer's son, prove capable of being taught them; in still other cases, as with Mrs. Chapman's and Mrs. Slack's children (I, pp. 51–2), and Mrs. Tilley's younger son, the child refuses to submit to tests, yet the mother satisfies herself from chance indications that the colors are really discriminated.

My niece at this period (under stimulus from color tests) took great delight in observing and recognizing colors—mainly as an intellectual exercise, but with some æsthetic pleasure. The effect in increasing her interest and enjoyment in the visible world about her was notable (I, pp. 34–56, 91–95). But I find marked interest in color at this age reported in but one other case, that of Mrs. Tilley's older boy.

Color tests at this period have always been undertaken with a view to determining the *order of excellence in seeing,* as between the different colors. The number of correct identifications of each color was expected to be in proportion to the distinctness with which it was seen, just as in a color test with an adult. If anyone tries, however, to get quantitative valuations of the color-perceptions from the numerical results of such experiments on a little child, he will be led much astray. In a rough way, the tables yield a great deal of information; but their quantitative accuracy is affected by the following considerations, all due to the limitations of the little subject's ability to conform to the conditions of the experiment:—

(1) When the method of identifying the colors by name is used, confusions in word memory arise. When Binet's "methode de reconnaissance" is used (showing the color, then mixing it with others and telling the child to pick it out) the color must be carried in memory; moreover, to a child in the second year the requirement is harder to comprehend than the simple inquiry, "Where is red? where is blue?" and I did not find the method practicable so early.

(2) Children misname, or select wrongly, out of inattention or whim, and such errors not only lower the total percentage of correct answers, but affect the different colors unequally, for the little ones have likes and dislikes among them that have no connection with clearness of seeing.

(3) The colors first introduced stand at a disadvantage as against those introduced later in the series, after the child has become trained in the experiment. If the color seeing does actually improve during the period, and if the period covered by the experiments is long (it was ten months in the case of Preyer's child), this may be a large source of error.

(4) It is next to impossible to get even an approximately equal number of tests for each color, partly because some are introduced late, and partly because of the child's whims and preferences; one color will be reached for over and over, and spontaneously identified, another the child will refuse to take into consideration at all, though you know him to be perfectly able to see it and name it.

Most of these errors a careful observer should be able to detect, and allow for. A name confusion, especially, he should be able to distinguish from real difficulty in distinguishing the color,—checking the formal tests, as he can, by chance lights, as when Mrs. Tilley's child, who refused tests, recognized bits of cloth promptly as like his brother's blouse, etc. Anyone constantly with the child knows his habitual whims and preferences among the colors, and sometimes their origin. Corrected thus by the observer's opinion, the experiments should give an *approximate* idea of the distinctness with which the respective colors are distinguished, but without any quantitative accuracy.

We have three series of such experiments relating to the period in question, Binet's, Preyer's, and my own, including in all nearly 3,000 single tests.[23] In the following table I summarize the principal results.

TABLE XIV. FORMAL TESTS OF COLOR DISCRIMINATION.[24]

Experimenter.	Binet.	Preyer.	Shinn.
Method.	{ Naming color [25] / Recognizing color.	Naming color.[25]	Naming color.[25]
Material.	Holmgren wools.	Magnus tablets.	Prang tablets.
Sex of child.	Girl.	Boy.	Girl.
Age when tests began.	2 years, 8 months.	2 years.	18½ months.
Duration of tests.	6 months.	10 months	3 months.
Percentage of correct answers.	Not stated.[26]	70.3.	92.7.
Apparent order of good discrimination.[27]	Red, blue, orange, chestnut, pink, violet, green, yellow.	Yellow, brown, red, violet, pink, orange, gray, green, blue.	Pink, orange, green, yellow, blue, brown, violet, red.
Probable real order, correcting name confusions.	Red, blue,[28] green, orange, yellow, chestnut, pink, violet.	[Green and blue probably would rank higher.]	Red, blue, yellow, orange, green, pink, brown, violet.

[23] I am passing over Dr. Garbini's few tests at this age. I should have to go into a detailed analysis of his tables to explain my inability to use them. But in brief, I find myself unable to deduce from them, in most cases, the same results that he does, and it is quite evident that he is dominated by a theory of color vision, according to which the child should be color-blind up to the middle of the second year; should then enter a period of red-green color-vision, which lasts until the 4th year, when blue and yellow emerge. His table for the second and third year is based on an examination of 8 children, each of whom seems to have been asked once to match each color, and once to name each color. That the children could name and match red best is evident enough; but beyond this his own table seems to me quite unable to support his conclusion in favor of red-green seeing at this period. Two of the eight children were able to match all the colors, and those who could not, gave not the least evidence of seeing green better than blue or yellow. (Evoluzione del Senso Cromatico nella Infanzia. Del Dott. Adriano Garbini. Firenze, 1894.)

[24] Binet, Perceptions d'Enfants, *Revue Philosophique*, Dec. 1890; Preyer, *op. cit.*, pp. 7–22; Shinn, "Notes on the Development of a Child," I, pp. 35–53.

[25] Including recognition of the color by name, as well as naming it.

[26] All the answers were correct by the "methode de reconnaissance," but the child was already three years old before this was begun. The results used in this table are those of the naming method, checked slightly in the last entry by some momentary errors made in recognition tests.

[27] I have omitted black and white from the table. There really is no question of the child's ability to see them. When he confuses some light color with the white, or some dark one with the black, it is his valuation of the color, not of the black-white impression, that is at fault. It is somewhat odd that white, which the baby seems to see sooner and like better than any

In eliminating as far as possible *name confusions* from the foregoing table of results, I have by no means eliminated all the sources of error, as may be seen from the footnote on blue. And even if we could arrive at a correct list of the order in clearness of perception, we must not confuse it with the order in the child's *preference.* A color that is actually disliked may be quite clearly distinguished.

What then do we get from these laborious tests? Three important results. The first is, that they prove beyond question the possibility of a complete perception of all the different color qualities in the third, and even in the second year,—a matter that floated on a sea of conjecture before. In the second place, after making all allowances for errors in the order of correct perception, there is still discernible a firmer vision and more interest toward the red end of the spectrum, and a weakening as violet is approached. And in the third place, when the experimenter's reports are studied in detail, the *types* of error that occurred are illuminating.

On this last point I must dwell. The errors (even slight and momentary ones, showing a *tendency*) that seemed to be due to real difficulty in discrimination, were as follows:—

TABLE XV. SIGNIFICANT COLOR CONFUSIONS.

Experimenter.	Binet.	Preyer.	Shinn.
Confusions observed.	White with pink	All very pale colors with white	White with pink.
	White with yellow.	All very dark colors with black.	White with yellow.
	Green with yellow.[28]	Green with blue.[28]	Violet with blue.
		Green and blue with gray.	

color, should be late in getting securely named. I can only conjecture that white presents itself to the mind in a sense as the norm, from which colors vary, and does not seem to need a name. It is known only by contrasts, and the contrasting surface gets the name.

[28] Blue seems, in these naming tests, to emerge to a higher place than might be expected, from the absence of any sure evidence that it is perceived in the first year and the early part of the second. There may be some element of suggestion in this: blue is pushed forward by the experimenter, to see if the child can distinguish it from red. Perhaps the child himself feels in it the decided contrast with red which the experimenter feels in pushing it forward, and so distinguishes it more easily. It is well learned before the colors that might be easily confused with it, green and violet, come on the stage.

[29] These errors persisted as name confusions, but seem to have begun in some real difficulty of discriminating the colors.

These confusions fall under two obvious generalizations:—

1. Feebly saturated colors are sooner confused with white, heavily saturated ones with black, than in adult vision. The chromatic quality disappears sooner at both ends of the scale. It is exactly as if the colors were seen in a feebler objective illumination than with us. And in fact, an actual lowering of the objective illumination seems to destroy or confuse the color to a child, when it is still quite clear to an adult; as when my niece called violet black, and yellow orange in the shadow (21st month, I, p. 46), and Preyer's boy, in the 4th year, saw light blue as gray in the dusk of morning.[30]

It may be that the chemical reactions of the retina are weaker in the child, and require a stronger light-shock to discharge the color process. But it is also an important consideration that the color-sensitive region of the retina is smaller than with us, so that the child gets the effect of a smaller tract of color, and therefore of a lower saturation.[31] Professor Luckey says:[32] "Representing the average range for the adult eye for the four colors as 100, the average for the thirteen-year-olds would be represented by 77, and the seven-year-olds by 61. . . . Now should we continue still farther backward, and this law hold true, we should finally reach a point in the child's development where the eye ceased to be sensitive to color impressions." At three years old, the color-sensitive region must be so circumscribed as to make an appreciable difference in the color-seeing,—and a difference of just the sort that we find existing.

"It seems probable," Professor Luckey continues, "that the child inherits from past generations an ever increasing color *tendency,* but nothing more; . . . the different color stimuli must play on the retina in order to develop this color tendency into a real mechanism for the discrimination of color." This is strikingly like Dr. Magnus's independent conjecture from the

[30] *Op. cit.*, p. 20.

[31] Professor MacDougall reports experiments showing that red loses least in intensity, green most, by reduction in color-area—a fact which has a bearing on the high value of red and low value of green to the baby.

[32] Comparative Observations on the Indirect Color Range. By Geo. W. A. Luckey. American Journal of Psychology, Vol. VI, pp. 489–504.

ethnologic point of view. We must not conclude, he says,[33] that the primitive condition was an analogue of color-blindness: actual inability to sense colors did not exist, but a condition like that of the periphery of the retina,—which is as good as incapable of color-seeing, yet by enough strength of stimulus can see them, and by due practice can be cultivated; this is a survival of the earlier condition of the whole retina.

It must be noted, however (and Professor Luckey does not fail to see the difficulty), that if the peripheral condition of the retina is really the analogue of the primitive condition of the whole retina, *blue* should be the color first noticed and first named; while in fact Professor Luckey, like most other observers, "questions whether his own children were able to perceive blue before they were 18 months old, while they knew and seemed to enjoy red, orange, and yellow very much earlier."[34]

2. There is a tendency to confuse colors next each other in the spectrum, at the short-wave end. Each child shows a trace of this confusion, but each with a different pair of colors. Professor Preyer thinks that green and blue were at first actually seen almost as gray. Considering the remarkably good discrimination of slight differences, all the way to the violet end of the spectrum, which my niece showed by the 22d month (I, pp. 42, 47, 53, 92–3), a better discrimination than she showed several years later, after her attention to colors had lapsed, I find it hard to think that there was any real defect of vision; but rather that the difference between these short-wave colors did not appeal to the children as important, exactly as men of average education constantly call violet "blue,"—not that they are seen as alike, but that the difference does not seem to be worth naming. Even women well trained in color are willing to call both salmon and rose "pink" though one is actually light orange and the other light red. To all of us, also, blue and green approach each other in quality as saturation becomes less, and, as has just been pointed out, the child probably sees all the colors as less saturated.

In this confusion of spectral neighbors, also, the parallelism with primitive races is striking.

[33] *Op. cit.*

[34] *Op. cit.*, p. 500.

During this period of a year and a half my niece's preference for the warm colors declined and disappeared, and she took more equal pleasure in all colors (I, pp. 55, 94),—another evidence of full development of the color perceptions. Nevertheless, the contribution of *light* to her enjoyment remained great, and for years a spangled or silver-woven white dress seemed to her (as to other children, so far as I have seen) more beautiful than any color. The distinction between light and dark saturations of the same color she comprehended at a word when 22 months old, and was able at once to generalize it (I, p. 52).

For color harmony, I can find no trace of feeling within the first three years, either in my own record or any other. Indeed, I suspect that it is a late and rare development among adults. Probably color itself, as distinguished from light, is less important to adults than they realize; to most of them the chromatic quality merely enhances the pleasure in brightness. It is easy to overrate the æsthetic feeling for color and for color harmony in civilized society, since people follow each other's lead so much in dress and decoration.

Summary.—The subject is far from being cleared up: but we are at least justified in the following conclusions:—

First, The child is insensitive to color at birth, and may continue so for several months, though here we have only negative evidence.

Second, Feeble color sensations, beginning at the lower end of the spectrum, and developing progressively upward, begin to be felt, certainly within the second half-year, and perhaps earlier. They include all the long-wave color sensations by the end of the first year, and probably the short-wave ones follow soon after, but there is no actual proof of the existence of these before the 18th month.

Third, By the third year, or it may be by the latter part of the second, the child has all the color perceptions of the adult, and can be taught to discriminate and name them quite perfectly, and to notice color in the world about him.

Fourth, Colors are seen by the infant more feebly than by the

adult, as if in a lower illumination. This difference grows progressively less, and has nearly disappeared by the third year. It is probably due, in part at least, to the restricted area of the color-sensitive tract of the retina.

Fifth, Pleasure in light precedes pleasure in color; next, pleasure in colors appears, depending jointly on their light-richness and their "warmth"; but by the third year the warm colors in some cases lose their advantage, and the cold ones may give as much pleasure.

But for color *harmony* no feeling is to be found in the little child.

4. FORM.

The recognition and discrimination of form, so far as it is visual only, has naturally a precedence over that of color, since light and shade alone supply the material for it. The understanding of solid form is of course not visual only, but requires much inference from tactile experience, and is to be classed as an interpretation rather than as a direct perception.

Before the fusion of tactile representations with the visual perceptions, all bodies must have been seen by the infant very much as plane outlines, projected against the background. Not that the characteristic massing of light and shade upon solid bodies could have been neglected in visual discriminations, even before it came to indicate solidity; still, pure outline figure must have made appeal to the infant's attention very early, or it could not be so remarkably well discriminated as it is before the end of the first year.

My niece first showed noteworthy interest in the visual aspect of objects in the fourth month (p. 71). Recognition of objects by sight rapidly followed, as has already been related, and in the eleventh month, outline pictures began to suggest the object (I, p. 72). From the beginning of the 12th month, she proved able to distinguish with nicety small outline forms, as the letters of the alphabet,—at first perhaps an inch in size, on blocks or cards, but very soon anywhere that she could find them, in ordinary text. She took, also, a spontaneous interest in these discriminations, and as soon as she knew that names

attached to the letter forms, desired to learn them (I, p. 58).

It is certainly instructive to notice that at an age when she was totally unable to comprehend the naming of such perceptions as red and yellow, she was begging to be given names by which she might distinguish the forms O and Q (12th month). I have no doubt that the names of the principal plane figures and of the letters of the alphabet were withheld from her long after she could have learned them with ease and pleasure. Her instant understanding of the names of the plane figures at a year and a half old; her deep interest in them; her efforts to draw them and her pleasure in having them drawn for her; her easy comprehension of the essential trait of form in oblong, triangle, and ellipse, even when they varied much in proportions and size; and especially her interest and joy in finding the world about her full of plane forms, her glee in detecting oblongs in the door panels, triangles in corners of collars, etc. (I, pp. 58–67),— all this made one of the most remarkable episodes of the second year, and affords a pedagogical suggestion that should not be thrown away. That a child of 22 months could instantly grasp the distinction of ellipse and circle, while at the same time classing long and short oblongs together without difficulty, seems to me most noteworthy.

The same cleverness in geometric perception was observable throughout the third year. It was merely visual, however, and did not include any comprehension of the numerical relations in geometric figures; witness the incident on page 102, Vol. I (33d month), when the child was unable to understand why I could not lay a square for her with *five* sticks.

I find no other record of direct experiment upon a child's perceptions of plane figure. But the readiness with which small outline representations are recognized is noted repeatedly; and also the ease and interest with which the letters of the alphabet are learned, in playing with ordinary building blocks.[36]

[36] O was named to Mrs. Tilley's younger boy in the 15th month. A few days later he pointed to a blue tile and called his mother's attention to a circle on it, pursing his lips and trying to say "O," and delighted when his mother named it. About four weeks later, he brought his mother the

Of any liking for symmetry in form, I saw nothing before the circular handle of a basket, saying "O." Toward the middle of the third year he began to ask the names of the other letters.

Mrs. Catterall's boy, by the 23d month, had picked up all the letters, apparently somewhat against the pedagogic theory of his mother, for he was "restrained from learning anything more." Mrs. Hoyt's daughter by the 25th month, Mrs. Tilley's older boy by the 26th, had learned all the letters in playing with blocks.

The following note, from the unpublished record of Mr. and Mrs. Cooley is too important an illustration of the precedence of form recognitions over color recognitions to be abbreviated:—

"He had a box of Bradley's blocks. These are red, blue, white and yellow; some have letters on both sides, some figures and letters; the letters are script as well as Roman, and there is also a German alphabet. Twenty-four have animals on one side, and figures or letters on the reverse. R. soon learned to select the picture blocks by the names of the animals. . . . In the 16th month, his father tried to test his sense of color with these blocks. Selecting a red and a blue block, he showed R. the red one, saying, "Red block"; then placing the two before the child, he asked for the red one. R. failed to understand. He selected either block at random; when by chance he took the right one, a demand for another red block completely nonplussed him, though he understood the word 'another' very well. He would take from the general stock another block of similar size and shape, but of any color. Other colored objects, books, balls, ribbons, were tried with no better results. Finally the blocks were tried another way. It seemed reasonable to suppose that, playing daily with them, the child might have learned to associate the animals he was so fond of picking out with the tint of their respective blocks. So a red block with the cat was placed, reversed, with several others, blue, white, and yellow, and R. was asked to find the kitty. He took the right block after one quick glance. The experiment was successful with the other colors also. But in a few days it was suspected that R. had more than color associations to help him. Accordingly, six yellow blocks, *letter side up*, were placed before him, and he was asked for an animal on one of them. He chose the block at once. Then larger collections were tried, and of all colors. The result was that out of the whole collection of 74, he knew, *by the characters on the backs*, the 24 animals. The backs did not bear a single letter, but two capitals and two small letters each: thus the goat was marked W w X x. The camel was once retired for three weeks, then replaced unseen, and found when asked for with no hesitation whatever. R. seemed curious to have some name for each block, and would often hand one up, pointing with interrogative grunts to the English or German letters. We were not anxious to fill his memory with symbols for blocks, but he learned in some way two of the letters, and the numerals from 1 to 10 (6 and 9 were of course interchangeable, as he had no means of telling when a block was upside down)."

The parents seem to have refused to follow the child's lead in the matter, but by the 34th month he had managed to learn all the letters.

fourth year,[87]—nor, for that matter, of any æsthetic preferences among forms. The theoretic beauties of the circle were absolutely nothing to the child; her only basis of preference was ease of holding and handling, when the forms were represented by cardboard tablets.

5. INTERPRETATIONS.

Distance.—I have already pointed out (p. 72) that even before the development of grasping, the baby had some data for distance estimate, in the feelings of passive movement when she was carried to and from objects, associated with the corresponding changes in feelings of accommodation in her eyes, and in the visual appearance of the objects; and also from the associated series of touch and movement feelings when the hand was carried across a surface. With the mastery of grasping, variations in the distance of desired objects, measured both by eye and by arm movement, came to the very front in hedonic importance. Nor were they measured by eye and by arm movement only, for the arm-reach was supplemented by leaning, turning, and bending the body. Objects, moreover, were not merely reached after, but pushed and pulled to and fro, or the hands passed over surfaces, while the eye watched. After the sixth month, locomotion, beginning in efforts to get the body nearer to objects beyond the reach of the arm, developed steadily, and the child became able to measure off longer and longer distances by creeping and toddling.

From the fifth month, then, distance variations within a range at first little beyond the child's arm-reach, and steadily widening to her ordinary and familiar walking distance, must have become well systematized to her consciousness, in terms of visual appearance, of eye movement, of touch, and of many movements (both felt and seen) of arms and body.

Such a focusing of different sense experiences must sooner or later give the common element in all the perceptions a high abstractness. To what extent this abstraction of the feeling of distance from the feelings of muscular effort and visual change

[87] "Notes on Children's Drawings," Elmer E. Brown, University of California Publications, Education, Vol. 2, No. 1, 1897, pp. 23, 62.

may have progressed at any given time within the first three years, I will not venture to guess. It is likely that to a year-old baby space within the compass of a room's width about him, to the three-year-old space within a garden's width, is measured off into distances that are seen much as we see them,—only longer, in so far as the valuation is based on the effort of traversing the spaces.

On the other hand, beyond the range familiar to muscular effort, my niece evidently saw distance very short, and objects correspondingly small and near. In the 18th and 19th months, the moon floated just beyond the reach of the arm, a tall man a hundred feet away seemed to be a boy much nearer; late in the third year, such an error was made only at the distance of perhaps a mile (I, pp. 20–21). We constantly make the same sort of error ourselves, seeing distance as too short, beyond a range pretty well measured by experience.

Under the head of Accommodation (p. 66) I have already given a comparative table of the increase of distance range of perception, which has some bearing on the present subject; for imperfection in the visual definition of objects outside a limited range of seeing, probably affected distance estimate. But its difficulties were mainly due to inexperience only, after locomotion was fairly established.

Size.—Such a conception as that of the "real size" of an object must be very slowly acquired by a baby, after much tactile investigation. At the time accommodation is acquired, he has not yet come to a perception of objects as identical wholes (p. 74). When that perception does form, therefore, it is based upon objects each of which is seen at varying distances, and so subtending various angles in the eye. The baby learns to recognize his mother's face from the first with entire impartiality whether it be seen as six inches or two inches long. It would not be quite true to say that there is no such thing as real size to him visually,—that one size is just as real as the other (for even before hand investigation has set a standard of size, other senses have checked sight somewhat; the mother close enough to touch and minister to the baby would seem the norm, rather than the

mother across the room); but it would be nearly true. My niece's indifference to size in identifying objects was quite striking; even at three years old, an elephant was an elephant, recognized easily in a three-inch toy, in a wooden sign some two feet high, and in the massive animal himself. And this is natural enough, when we remember that the living elephant seen some fifty feet away, was no larger than her toy.[38]

It is conceivable that the child may for a time tend to think of objects as actually diminishing as they retire. But at some time in the process of conception forming, the eye yields to the evidence of joint hand and eye experience, and the mother across the room is regarded just as large as at arm's length.[39] By the time the words *big* and *little* are used,[40] the child must rest upon some sense of fixed and real size in objects. I found that at three years old, indifferent as my niece was to size in recognizing the elephant's form, she had a pretty fair idea of what his size actually was, in terms of other objects (I, p. 105).

I append a comparative chronological table of the appearance of words indicating size concepts, up to the close of the second year:—

[38] Here we have probably the explanation of children's ready recognition of small photographic representations, and other pictures of known objects. The father in the photograph is no smaller than the father to whom the baby waves his hand daily out of the window.

[39] In adult life, as is well known, this empiric correction of the visual angle, by which a man across the garden actually *looks* to us life-size, fails rapidly as soon as the distance is sufficient to blur the detail of the image much. There is reason to think that this is still more the case with little children; and with a young infant we may safely conjecture that the apparent size of objects falls off very much more rapidly with distance than to our eyes. No doubt, too, the infant's belief, so far as he attends to the matter at all, is at one with his sight; unless the distance is so moderate and the object so familiar that the empiric correction has been securely made, he must really regard the distant object as smaller. Here may be part of the reason why a little child so readily believes in transformations of size (Sully, *op. cit.*, pp. 98, 105). (See my paper, "The Visible World of a Little Child," *University of California Magazine*, March, 1895.)

[40] The words at first meant "larger" and "less," used only together, of two objects compared with each other, even though varying but slightly in size; within two or three months they came to be used more as we use them, to compare an object with a medium or average standard of size; but the earlier use was apparent up to the 23d month (I, p. 66).

TABLE XVI. EXPRESSION OF SIZE CONCEPTS.

OBSERVER.	WORDS.	DATE OF APPEARANCE.
Hall	big	16th month (record closes with the 17th month)
Shinn	big, little	17th month
Price (1st child)	big, little	20th month
(2d child)	little	20th month
Sully	big	21st month
Wood	big	21st month
Tilley	big	22d month
Gale[41] (2d child)	big	Before 23d month
	tiny	23d or 24th month
	wee	24th or 25th month
(3d child)	large, little	23d month
Moore	little, big, great	By end of 2d year
Holden (both children)	little	By end of 2d year

Direction and Locality.—We have already seen (pp. 72, 113) that by the time auditory and tactile-motor contributions come into union with visual, the child has already begun to make some inferences of direction and location in space. In the 19th week my niece first showed the expectation that an object might be found on an extension of the line in which it had passed out of her field of vision (I, p. 23). But at six months old, she still rested on unintelligent expectation from experience in matters of direction and locality not quite so simple. Having been ac-

[41] In the first half of the third year, Mrs. Gale's oldest child also used adjectives of size, viz., big, wee, and large; the second child added little, large, small; the third child tiny and small. Mrs. Hoyt's older daughter used big, little, and small in the first quarter of the third year. I have no tabulated records of speech in the third year from any other source; but I think words descriptive of size will always be found in use early in the third year, unless the child is slow in speech development.

Mr. Cooley mentions here an interesting bit of early synesthesia. His boy in the 30th month, in naming two things of the same kind, but of different size, always named the small one first in a high and squeaky tone, then the larger one in a low note. Later, the high tone was always used to express small size, even when no contrast was involved. His father thinks this may have come from comparing the bark of large and small dogs. But I think most children use more or less this method of expressing vividly the contrast of large and small—and indeed, in talking to children of the "little, wee bear" and the "big, big bear" and the like, we do it ourselves, quite instinctively. We see the same synesthesia reversed in my niece's description of high notes as "little" (21st and 22d months, I, p. 118).

customed to watch people leaving the room by a certain door, and at once becoming visible outside through the window,[42] she turned and looked out of this window expectantly when her mother left the room by an *opposite* door, which she was not in the habit of using; but when I left the room by this door, which I used daily, or her mother by one that led to her own room, the child never thought of looking through the window for us. At the same age, however, when taken once out of a room, and back into it by a novel cross-cut, she showed by her surprise that some vague preconceptions of locality and relations of places were present to be jarred (I, p. 88).

By the seventh month, her attention could be drawn imperfectly in a given direction by motioning with the hand, but she could not follow a pointing finger accurately till the 9th month.[42a] Her own pointing developed later than this. and apparently not so much from any idea of indicating a line of direction, as from a habit of reaching the hand toward a desired object, as if to grasp. After she could creep and walk, her understanding of the location of objects seemed clear; but even at two years old it was more disconcerted by darkness than ours (I, p. 24), and this may not have been wholly because direction was more purely visual with her than with us, but also because in the light she steered a good deal by known objects, instead of by any general feeling of direction. It is well known how easily children, even of five or six years, get lost as soon as landmarks are out of sight.

Direction up and down is probably not systematized to the baby's perception as early as direction right and left. He has much early motor experience of up and down, as he is lifted and lowered, and he gazes upward a great deal in the early months, when he lies upon his back. But there is little opportunity to carry the eye up and down, and to verify visual experience by tactile-motor, until he is sitting up, and looking from one object to the other, higher and lower. I know no record of the progress

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[42] A note of Mrs. Hall's shows her baby forming ideas of direction and position by a similar practice, in the 37th week.

[42a] In the 6th month, Mrs. McLeish; 9th, Mrs. St. John; 11th, Mrs. Hall and Mrs. Beatty.

of this interpretation, except in the practice (common to all babies, I suppose) of throwing objects down and watching them as they fall, and as they are picked up. It is no doubt the motion and impact of the falling object that makes this experiment so deeply interesting to the infant investigator, but he gets the space interpretation from it incidentally. I have already given citations (p. 148) showing that the development is very irregular in the time of its appearance; but it may be roughly credited to the third quarter-year.

I saw my niece in the 41st week (I, p. 347) creeping to each corner of the hall in succession, to sit down and run her eyes up the walls. No doubt babies familiarize themselves with this space interpretation in many such ways, which we fail to note.[42b]

Solidity.—With the period of joint hand and eye investigation, a certain distinction between plane and solid form developed at once to the baby's consciousness. She learned, that is, to distinguish which type of visual objects could be laid hold of and which could not. After the 20th week,[43] she scarcely ever tried to pick up shadows, figures in the table-cover, and the like,—making really no more errors than a grown person might do among objects so novel; we ourselves are easily deceived as to the solidity of objects by a slight change in the distribution of light, for instance. But it is significant that when the baby had mistaken a plane figure for something that could be grasped, she did not instantly recognize the mistake on touching it, but in several instances kept up somewhat persistently the attempt to get hold of it. An adult has the categories of plane and solid so thoroughly differentiated in conception that a touch reveals

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[42b] My nephew, up to the 10th month, has been conspicuously diligent in exploring space upward with his eyes, as in gazing up a staircase well, or up the trunk of a tree to the branches.

[43] Mrs. Beatty and Mrs. Catterall both mention grasping at plane figures as conspicuous in the first week of grasping, but do not record it later; Mrs. Cook saw it in the second month afterward, Mrs. Conard in the third, and Mrs. Tilley until after the baby was nine months old, and had been grasping freely for more than four months. I have no record of anything that seemed to me a real confusion of plane and solid in my nephew for more than two weeks after grasping had become a habit, in the 6th month.

to him his error,—even changing the whole aspect of the figure to his eye, so that he cannot make it look other than plane, when a moment before it looked solid.

Even at nine months old, when much practice in handling bodies and feeling over surfaces had made my niece well able to distinguish them by sight, and no error had been made for about three months, she persisted in trying to pick up the shadow of a swaying rope end. The motion brought it within the category of things that could be grasped, in her experience, and she followed experience, not any general conception of the difference between surface and solidity. The confusion was never made later than the 9th month, however; and by the 11th month, outline figures seemed to be accepted for what they were, without the least expectation that they could be perceived by touch.

To differentiate seizable figures from plane outline, however, is a simpler process than to learn to understand them, in their solid extension and form. The interpretation of a solid figure, I take it, consists in learning to infer its extension to hand investigation from its visual aspect, and then fusing the hand memories of it with the visual aspect so completely that it really *looks* to be what the hand knows it is. There is reason to think that this interpretation is but slowly worked out. It is a complex and difficult one. Each object must be perceived in outline on different sides, and these various perceptions indissolubly associated; and a similar extensive group of touch perceptions must be formed and fused with each other and with the visual group, before the object can be seen as solid; and this must be repeated for a number of objects before the association of a certain appearance with projection or recession of surface can be generalized, and later come to the clearness and instantaneousness of a single perception. Nor does there seem to be anything in this trait of solid extension that interests the baby, and fixes his apperceptive attention upon it. I never saw the extension and figure of objects deliberately investigated. The enormous amount of manipulation bestowed on them was devoted to other purposes. Surfaces were felt over for their texture; objects were turned over and over, pulled around, shaken, but the mo-

tive seemed to be the desire to feel and to see the thing move under the hand, to work a change upon it, not to satisfy curiosity as to its form.

I have no doubt, however, that in the course of this handling a general interpretation of the solidity of tangible objects was very soon made, so that near and familiar ones, at least, came to be seen as solid. The visual and tactile images of our features must have been well fused in the 14th month, when the baby could locate and recognize them in the dark (I, p. 142). But while the general idea of solidity may have become well fixed, and even the specific forms of a few familiar objects fairly defined, I doubt if more than a few were thus known, early in the second year.

At 22 months old, the child was taught the principal solid figures (cube, cylinder, and sphere), with considerably more difficulty than the plane figures had cost at 18 months; and there was a marked disposition to recognize them by their faces, calling a cube a square, a prism an oblong, a diagonally bisected cube a triangle (I, pp. 68–70). It was hard to get the child to generalize these forms, so far even as to accept blocks of larger size under the same category as her small cubes; and though before the end of the third year (35th month) she could recognize the solid forms in nature when asked, she never noticed or named them spontaneously (I, pp. 102–3). It was impossible to interest her much in their properties, or in any of the kindergarten manipulations of them.

Understanding of Pictures.—The earliest demonstrations of interest in pictures, recorded in my own notes and those of others, are far from showing any understanding of the purpose of the picture. It is a conspicuous object, hanging on the wall or displayed in a book, and excites attention and curiosity, just as a conventional figure in a carpet does. Even when the child has been taught to recognize the picture by name as "Mr. Longfellow," or "Bébé,"[43a] the name means, as M. Taine says, nothing more than "something variegated in a shining frame."

[43a] I, p. 71; Taine, *op. cit.*, p. 26.

"The objects drawn or painted in the frame are as Greek to her." Yet the infant sometimes shows a peculiar interest in these mysterious objects, about the last quarter of the first year. Possibly their very meaninglessness excites his curiosity, at a time when he is just investigating everything, and usually finding some content in the way of movement, noise, tangibility. However that may be, a period of uncomprehending interest in pictures seems always to be followed soon by a discovery of their resemblance to known objects,—aided very likely by suggestion, as the elders name the picture to the child.

This discovery dawned on my niece, I thought, late in the 10th month, and was fairly accomplished in the 11th (I, p. 72). Horses, dogs, flowers, and even such minute features in pictures as a ball, eyes, etc., came quickly to recognition; but photographs of known persons not till the 14th month.

The fine visual discrimination and close attention shown in these early recognitions is wonderful. My niece in the 13th and 14th months would point out "kitty's eyes," "the man's glasses," feet, etc., in small pictures; at 19 months, the beaks of birds,—and this with much spontaneity. Mrs. Hall's boy in the 14th month recognized a dog half an inch long, and pointed out the shoes in a picture of a doll, in which the doll itself was only 7/8 of an inch long.

The interest shown by the little ones in these recognitions is endless. At first it seems to be simply a joy in perceiving the resemblance, something akin to their joy in fitting concepts with names. There is a deep and primitive delight to the child, from the earliest synthesis of senses, in bringing a whole range of perceptions into parallelism with another range,—a pleasure well in accord with the Spencerian "economy" theory. I must refrain from any discussion of this, however, for it would carry me far beyond the topic of the senses. Later, the simple delight in discovering resemblances, and in becoming acquainted with a pictured world corresponding to the real world, becomes more complex and intellectual. The child takes an interest in the story of the picture; ideas are profusely suggested; the picture becomes

the key to a greatly widened psychic life, and the source of remarkable enjoyment. This advanced stage I dated, in my niece's case, from the 18th month (I, pp. 76–7).

The following table gives comparative dates for such stages of progress in understanding pictures as I find generally recorded:—

TABLE XVII. UNDERSTANDING OF PICTURES.

	DATE.	OBSERVER.
Earliest recognition	8th month	Hall, Daniels (girl), Hoyt (boy)
	10th "	Shinn (girl and boy), Tilley
	11th "	McLeish
	12th "	Wood, Cook
	13th "	Moore, Pollock,[43b] Cooley
	14th "	Catterall
	15th "	St. John, Taine
Recognition of photographs	11th month	Tilley
	14th "	Shinn
	15th "	Daniels (girl), Hall
	16th "	Wood
	25th "	Preyer
Story of picture interests; complex ideas suggested	18th month	Shinn
	21st "	Cooley, Moore
	23d "	Hoyt (boy), Tilley (1st boy)
	28th "	St. John

Of the "earliest recognitions" in this table, none of those dated in the second year seem to me to have really been "earliest." Either the child had not been tested with pictures before, though he might have proved well able to catch the resemblance to the object; or else the entry seems to have been made when the recognition, though still new, was not quite in its earliest stage. So, too, the entry that seems to date the more complex interest in the third year did not, apparently, record the phase

[43b] See bibliography in Prof. E. E. Brown's "Notes on Children's Drawings," University of California Publications, Education, 1897, and later titles in the annual Child-Study bibliographies of Clark University. But I must mention especially, for an able consideration of the questions relating to this very early period of interest in pictures, Prof. Sully's chapter on "The Child as Artist," *op. cit.*, p. 298.

at its first appearance. We may fairly enough, then, set down the dawn of recognition of pictorial representation as a development of the last quarter of the first year; the recognition of photographs (that is, of specific and individual resemblance in pictures) will appear about the first quarter of the second year; and interest in the story of the picture and in a considerable range of suggested ideas, in the latter half of the second year.

When we consider how much there is that is conventional in our system of pictorial representation, it is remarkable that the child is able so early to relate the picture to the object, and so greatly to enjoy and profit by this art language. The comprehension is even carried so far that the real object is recognized from the picture. Thus my niece in the 36th month recognized an elephant; and Mrs. McLeish's little girl recognized cows, as early as the *14th* month. I should be going beyond my topic, again, if I entered upon the interesting subject opened up by this precocious readiness of the child mind for pictorial art; and it is a subject that has already been ably discussed more than once.[43b]

II. HEARING.

1. SENSIBILITY AND DISCRIMINATION.

In the chapter on Auditory Associations (pp. 119 *et seq.*) it has been shown that cochlear hearing, appearing about the end of the first month, was in all recorded cases fairly good before the period of sense synthesis was over,—by the sixth month at latest; in one or two cases, the responsiveness to sound was remarkable by the 5th month. My niece did not show a really lively responsiveness till the 9th month (I, pp. 108–9); at this time, she would stop and listen at the slightest novel sound, distant or near,—if a horse stamped, outside the house, fifty feet away, or if a pencil dropped on a matted floor. This phase of remarkable auditory alertness lasts a month or two and then passes away; it probably indicates a sudden advance in susceptibility to sound, which interests intensely while it is novel, and

then comes to be accepted as a matter of course. I do not find it mentioned at all, however, in most records.[44]

It is evident, however, from scattered notices, that hearing does become more acute throughout most of the first year. For some months this is apparent in an increased sensibility to auditory shock,—the child starts and winks more readily at slight, sudden sounds; but on the whole, as cochlear hearing develops, the element of shock in sound is less noticed,—or perhaps it is only that the reflex excitability becomes less.

There is from the first a hedonic sensibility to differences in sound, long before intelligent discrimination and recognition are present. Jarring or startling sounds are almost always disagreeable, while music, from the first establishment of cochlear hearing, affects all children agreeably. Sounds of more neutral hedonic quality differentiate later to the ear; but the human voice is apparently in a general way differentiated from other sounds as early as the second month (p. 120 *et seq.*). By the 5th month my niece began to show that she perceived differences in quality between individual voices in the family.[45] Differences in tone are also perceived, even earlier than this, but their hedonic effect varies with different babies.[46] At about the same time that differences in voice were perceived (5th month), my niece showed discrimination between verbal

[44] Preyer's child reached the phase in the 5th month; Mrs. Tilley's older boy in the 6th; Mrs. McLeish notes it as beginning in the 5th, and culminating in the 8th. It appeared in my nephew in the 9th.

[45] *Recognition* of voices is a more advanced development, requiring the association of each one with the speaker. I find this dated in several records (p. 193); the earlier stage, mere perceptive discrimination, only in Mrs. Tilley's MS., where it is assigned to the same month as in my notes, the 5th.

[46] From the 3d month, Mrs. Hall's and Mrs. Cooley's babies were painfully affected by shrill tones; Mrs. Cook's, from the 3d to the 7th month, laughed immoderately at imitations of peeping or mewing, and also of grunting, but was frightened at growls; my niece from the 6th month, for some weeks, was made very uneasy by a deep, vibrating voice. Mrs. Saunders's boy as early as the 7th week, Mrs. Tilley's in the 3d month, Tiedemann's and Preyer's sons and my nephew in the 6th, cried at a harsh tone; my niece, at six months, stared, then laughed, when the same experiment was tried with her several times.

sounds, certain combinations of consonant and vowel exciting her to gayety. (I, p. 112).[47] From the 6th month, the increasing ability to distinguish spoken words showed a fine auditory discrimination. This is noted in other records as beginning from the 5th to the 12th months (see below, p. 196).

2. MUSIC.

Musical Sensibility.—All infants, so far as any observer has recorded, experience pleasure in musical notes, from the beginning of cochlear hearing,—as early, at all events, as the second month. The pleasure must be wholly direct and sensuous, to appear so early, and no doubt has to do with the exact mathematical adjustment of the musical vibrations to the physiology of the organ of hearing. The agreeable effect of single notes and chords (which was apparent in my niece earlier than any interest in regular tune) is about as simple as that of light falling upon the eye.

After the middle of the second year my niece desired real playing, not mere scales and chords (I, p. 117); and her enjoyment of music was at times quite vivacious. But it was certainly not a consistent and dominant pleasure at any time within the first three years of her life.

Other children may have shown more decided pleasure in music; the records are not full and consecutive enough to enable me to tell. On the whole, one gets an impression of less musical susceptibility in the American infants than in the German ones mentioned by Preyer.

Sense of Rhythm.—The feeling of rhythm is of course not wholly—nor even primarily—an auditory one; but it is most easily considered in connection with music.

It might be possible to determine by experiment how much of the pleasure in music shown by young infants is due to rhythm, and how much to tune, but it has never been done. My niece, before the end of the second month, could be diverted by lively music when slow music failed;[48] and strongly accented music

[47] Mrs. Tilley, 6th month.

[48] Mrs. Daniels's boy, in the 4th month, showed delight in "bright, fast music—crying if it is loud or sad." See also Tracy, Psychology of Childhood, I, p. 95.

moved her unusually (with astonishment) in the 4th month (I, pp. 115–6). To be danced with, in some one's arms, in time to music, gave her extreme delight in the 16th month; and her first recognition of tunes, in the 25th and 28th months, seemed to rest more on their strongly accented time than on the melody. Nevertheless, she could not be taught, at any time in the first three years, to march or keep time to music in any way, or even to keep step with us; it was not till the 30th month that she could even learn to swing a ball to and fro in rhythm, or could say "far—near," in time with the movement. In trying to sing herself, she could not approximate the time of any melody until the 30th month.

I judge from the silence of most records that my niece's development did not differ much from that of the average child in the matter of ability to keep time: but as will be seen by the table below (p. 191), there are several cases of good sense of rhythm early developed.

Pitch and Tune.—The emotional effect of extremes of pitch upon infants is early apparent.[49] But it was not until the 18th month that my niece attended to them consciously, reaching up and down the keyboard to strike contrasting notes, and calling high notes "little" (21st and 22d months). She could not take any pitch with her voice before the 4th year. Until the 26th month, she was utterly incapable of understanding what was wanted when a note was given her to imitate, and would shout it back without an effort at pitch or musical tone. After this, she gathered some idea of making an interval in pitch, but could not do it with the least correctness; still less could she approximate any air, however familiar (I, pp. 122–3). She had not even recognized any air before the 25th month, and then it seemed to be more by time than by tune.

In this respect, as in sense of rhythm, I find few children reported much earlier in development than my niece;[50] but here also

[49] See note 46, p. 186. But high notes on the piano do not displease, as in the human voice. "The higher the better for him," Mrs. Tilley notes in the 3d month. See also my "Notes," I, p. 118.

[50] During later childhood she developed a fair average musical taste, and correct perception of time and pitch.

some children show marked precocity (see Table XVIII, below).

Spontaneous Musical Expression.—It is important to notice that while efforts to impart our own musical development to the baby fail, except in cases of precocious musical endowment, there is usually a sort of spontaneous and primitive musical development going on, along somewhat different lines.

In almost all cases, the sound of music seems to excite the baby, almost from the first, to a motor accompaniment, either of limbs or of voice,—but purely as a discharge of the emotional tension produced by the music, a self-expression, without the least attempt at imitation of the sounds, either in time or tune. Thus, at about two months old, my niece would accompany music with a soft, singing sort of coo; at eight or nine months old she would contribute wholly unrelated notes of her own when others were singing; at a year old, she kept up a low crooning while falling asleep,—apparently an expression of a general mood of comfort, similar to that which music induced; but possibly a reminiscence of her mother's lullabies.

In the 18th month, she began to amuse herself with a sort of tuneless chanting or crooning of syllables, which became a regular expression of happiness while she played about. The pitch scarcely varied from a monotone during the second year, but during the third it grew more varied, rhythmic, and modulated, until—while quite without any real tune, or even recognizable intervals—it had a pleasing and musical effect. The child's joy and spontaneity in this exercise, and the degree of real music there was in it, contrasted significantly with her reluctant and ridiculous efforts at civilized songs. During the whole third year she occasionally chanted in words, sometimes mere fragments, sometimes quaint little improvised verses,—sometimes touching the piano softly as she improvised, sometimes dancing about joyously. In the next two years, these improvisations sometimes actually attained to correct rhyme and metre; but as the little girl became able to sing in more sophisticated fashion, and learned to enjoy the poetry we gave her, this primitive art died out.

I find instances in other notes, both of the early cooing to the sound of music,[51] and of the later primitive chanting,[52] while still unable to reproduce our music; and I am inclined to think that both occur oftener than has been recorded. The chanting is in fact, like that of primitive peoples, a sort of recitative, which could probably be analyzed into imperfect musical intervals.

Summary.—What we may call a normal musical development, then, in the first three years, does not go beyond a pleasure in listening to music, especially to lively music with well-marked time; and this pleasure, though real and universal, is not one of the foremost to the child.[53]

It is rarely that the mathematical accuracy of rhythm and pitch required by our music can be attained before the fourth year; but left to a natural outflow of musical expression, the child starts out to develop a musical system for himself, from its crude primitive beginnings.

There follows a table of the comparative chronology of musical development, so far as I can find it recorded for different children; the silence of most records seems to imply absence of such development.

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[51] "The mother's singing soothed the child, so that he ceased crying to listen to it, and when to the rhythm of the music she swayed his hands, held tightly in hers, he crooned a soft, continuous musical tone as long as the singing continued." (36th day.) Mrs. Hall, *op. cit.* See also MS. of Mrs. Tilley.

[52] Mrs. Tilley's younger boy, from the 15th month to the 28th (when the record in my hands ends), developed a habit of singing "tunes of his own making" with a fairly musical voice, but no regular intervals. See also Preyer, The Development of the Intellect, pp. 171, 185; Mrs. Moore, *op. cit.*, p. 62; and the MS. notes of Mrs. Daniels.

[53] I can find no evidence anywhere of a susceptibility in the child to a hypnotic sort of excitement through rhythmic motion, such as is familiar to the anthropologist. Probably the baby is at a still earlier stage of musical development; and before he has acquired the savage's susceptibility to musical excitement he has been diverted by teaching to our more controlled and quieting musical system. Or it may be that he has not yet the passions and impulses that music can work on strongly. It is certain that the sight of a dog or cat, the achievement of some feat of self-activity, the prospect of going outdoors, will throw a baby into a condition of excitement and joy that no one has yet recorded as caused by music, even in the case of the most musical babies.

TABLE XVIII. DEVELOPMENT OF MUSICAL SKILL.

STAGE OF DEVELOPMENT.	DATE.	OBSERVER.
Keeping time to music by movements	12th month	Chapman[54]
	At a year old	Wells[55]
	Nearly two years old	Preyer
	Not yet seen, at 32 mos.	Tilley[56]
	Not before 4th year	Shinn
Recognizing an air[57]	20th month (2d child)	Tilley
	21st month (1st child)	"
	28th month	Shinn
Giving a note or interval correctly	8th month	Safford[58]
	9th month	Friedemann, cited by Preyer
	28th month	Tilley
	Not till 4th year	Shinn
Singing an air correctly	15 months	Helliwell[59]
	"Before they could talk"	Friedemann, cited by Preyer
	2½ years	Observer cited in the Talbot papers—child in Holland[60]
	Nearly 3 years	Preyer, Daniels
	Not till 4th year	Shinn

3. INTERPRETATIONS.

Source and Nature of Sound.—The mere association of sound with visual and muscular experience is soon made,—by the 4th month, in almost every case (p. 130). Its interpretation as something originating in an objective source, and made by some process of movement, and the reference of various sounds to their proper origin, begins from the fourth or fifth month, and is actively in progress throughout the second year, at least. At

[54] The same child by his 20th month could keep the polka step for six measures at a time.

[55] Letter of Mrs. Flora Ellis Wells. The mother is herself a musician.

[56] The same child, in the 32d month, in repeating songs, would fill out the rhythm and accent correctly, where he had forgotten the words. Mrs. Moore's child did this in the 22d month.

[57] Mrs. Moore reports this in the *17th week*. The date is so extraordinary that I do not venture to insert it in the table—the more as Mrs. Moore does not give the observation in detail, but merely states the item.

[58] MS. of Mrs. Gertrude Sunderland Safford, Michigan University, 1895. The child followed the notes of a cuckoo clock almost invariably with an "m'm
\
m'm" in the two pitches. The same child in the 11th month imitated a passage of staccato singing.

[59] Several songs.

[60] A mere fragment of an air.

what stage the interpretation really takes form, it is hard to say. By the time the child asks, "What made that noise?" "Where did that noise come from?" he must understand the origin and nature of sound much as any unscientific grown person does. But I do not find record of such questions within the first three years.

One thing is evident: the interpretation must take two directions in his mind. (1) The sound by means of which he first begins to associate sound with a visual source at all, the human voice,—the sound which somewhat later becomes the most interesting of all to him, in connection with his own vocal activity,—never comes to seem to him in need of accounting for by any movement or impact of objects.[60a] It becomes a factor, on the contrary, in his feeling of the self-activity of living beings. (2) His own manipulations of objects to produce noises, however, and his observation of their production by the acts of others, by falling bodies, etc., must build up in his mind a conception of all noises except the voice as somehow made by a visible process of movement.

This process of interpretation could be seen beginning, in the case of my niece, early in the 5th month, in a lively and wondering interest in watching the making of noises. Unless she could see the noise-making process, sounds did not greatly interest her. In her own noise-making,—ringing a bell, blowing a whistle, rapping things together,—she did not at any time seem to me to care so much for the sound in itself as for the relation of process and result. After making a sound by her own act, she would ask to see it done by others (9th–13th months, I, pp. 129–30). She was interested especially by *novelty* in sound, or in the method of producing a familiar sound; thus in the 14th and 15th months, she did not care so much for her rubber doll's squeak in itself as for making it squeak in irregular ways, by stepping on it, or jumping it up and down. Throughout the whole three years, sounds were a source of lively interest, but not from pure sense pleasure in them: the child wished to see what made them, how it was done, and to get them referred to recognized sources. The first sounds thus referred were the

[60a] For this note, see p. 222.

voices of the family, one by one, from the 8th or 9th month to the 11th;[61] few other sounds within the first year; but in the second everything was recognized and referred to its source.

All records that I have examined confirm my own in the above observations. That is, the child's interest in sounds is always considerable, and develops remarkably in the second year; but except in the case of music, it is not a pure sense pleasure. There is practically nothing of the "noise-hunger," as President Hall calls it, which really does seem to exist among older children. Of the babies, even the noisiest was evidently interested more in producing effects by self-activity than in filling his ear with sound. Professor Preyer and Mrs. Hall both record instances in which the child's curiosity about variations in a sound led to experimenting of a remarkably intelligent sort for children so young.[62]

With all his observations and experiments in the origin of sound during the second year, it would seem as if the child, by the latter part of this year, should have a fairly clear elementary interpretation of the nature of sound. But it is possible that in case of a sound which seems unaccountable, as the wind, or an echo, a child can still, at this age, become confused, and fall back upon the conception of an *object* (p. 127). My niece, in the 20th month, puzzled by an echo, begged to "find the noise," "see the noise," and I could not feel sure how far she was merely unable to express the conception "thing-that-made-the-noise," or how far a sound that did not come under known categories as to origin, might be attracted over, so to speak, in her mind, into the better-known category of objects.[62a]

[61] Sigismund and Mrs. Hall, 5th month. Demme, cited by Preyer (*op. cit.*, p. 91), found two children, out of about 100 tested, who seemed to recognize the voices of their parents at 3 and 3½ months. This was a more primitive sort of "recognition," a mere hedonic association with the sound, not an interpretation of it by definite reference to a known source. It is possible that the recognitions noted in the 5th month were still of this type.

[62] See the investigation into the cause of the dulling of sound when the child's hand touched the glass he was tapping with a spoon (11th month), Preyer, *op. cit.*, p. 87; and a similar instance (9th month), Mrs. Hall, *op. cit.*, p. 466. I have seen the same thing in my nephew (9th month).

[62a] See Prof. Sully's instance of the little girl M., who asked to see a knock (*op. cit.*, p. 97),—"reifying" the sound, as Prof. Sully puts it.

The weakness of the sound-conception here is obviously due to its resting on the testimony of a single sense; on p. 197 I give a parallel instance of a weakness felt in the conception of a color, because it rested on the evidence of sight only.

Certainly my niece's consciousness of the act of hearing was less clear than that of seeing, for in the 21st month she could tell very well what she did with her eyes, but had not associated her ears at all with hearing (I, p. 133). The word "hear" did not appear in speech till the 21st month, "see" in the 18th; and in this evidence from speech all other records support mine.[63]

Direction and Distance.—Within the earliest period of sense development, about the third month (p. 130), the child comes to a good association of sound with visual direction, if the source is near by, and nearly in the horizontal plane of the ear, to left or right. From this time, the more difficult inferences of direction develop, resting on accumulated experience and finer auditory discriminations. They seem to me to develop with remarkable ease and accuracy.[64] In the 14th and 15th months, my niece could run directly toward the sound of my voice in the dark; in the 19th, hearing a bell ring a mile away, she moved accurately toward the sound (I, p. 110). From the 6th month

[63] Prof. Holden notes "hear" and "listen" in the 24th month. I do not find "hear" in any other vocabulary before the third year, though "see" appears in all; one of Mrs. Gale's children, however, used "listen" in the 24th month, and "hark" appears in the two-year-old vocabulary of Mrs. Moore's child. "Music" is used early as a rule (Shinn, 17th month, Gale, 22d and 24th, Moore before 3d year), and also "noise" (Hall, 17th month, Shinn 20th, Gale 22d, Moore before 3d year); and also some names of specific noises, as "squeak," "bang," "tick." But if we pass over the naming of animals by their voices which is taught to children, and comprehended by them readily even before the second year (bow-wow for the dog, moo for the cow, etc.), and the imitations of animal sounds, the total number of sound-concepts in the vocabulary of a two-year-old child is very small. I find it ranging from one word up to some 15 or 16; while the concepts of fused visual-tactile character that are expressed at the same age, will range from 200 to 600—including nouns, verbs, and adjectives.

[64] Mrs. McLeish notes rapid development in turning toward sounds, even at half a block distance, or on another floor of the house, in the 5th and 6th months (*op. cit.*, p. 114). Mrs. Beatty also notes the accuracy with which the train bell and whistle were located, several blocks away, from about the same age.

she became slowly able to locate sounds further and further above her; but even in the 20th could not locate an electric bell directly above her head (I, pp. 109–10).

Her ability to infer distance from the sound also grew steadily, and from the 20th month she distinguished very well between a "choo-choo 'way off" and one nearer, by the whistle, a comparatively easy sound for this discrimination (I, p. 113).

Language.—So far, I have spoken of no ear interpretations that approach in psychic importance those made by the co-operating hand and eye. But when the infant begins to associate a given vocal sign with an object, a feeling, an expectation, so that at sound of the word the associated idea comes to his mind, the ear begins to come to a psychic importance that is destined to outstrip that of the eye.[65]

At six months, my niece had associated the long vowel sound in her name, pronounced in a calling tone, with some sort of prospect connected with herself, so that she would turn expectantly at a call, not only of her name, Ruth, but of Toots, or any other monosyllable containing the *oo* or *u*. At seven months old, she began to associate the names of members of the family with the proper persons, and so went on to an increasing knowledge of words. With the second year the number of vocal signs thus associated with ideas passed beyond enumeration, and the child had already begun to imitate them with her own voice. The acquisition of language, thus begun, was the great achievement of the second year.[66]

The date of this attainment varies somewhat,—a little earlier

[65] "The great superiority of the ear to the eye, from the psychogenetic point of view, is but slightly prominent upon superficial observation of the child that does not yet speak; but we need only compare a child born blind with one born deaf, after both have enjoyed the most careful training and the best instruction, to be convinced that after the first year, the excitements of the auditory nerve contribute far more to the psychical development than do those of the optical nerve." Preyer, *op. cit.*, p. 182.

[66] See Romanes, Mental Evolution in Man, as to the precocity of the acquirement of language by children of our day. Four years, he shows reasonably, is an age corresponding better to the phylogenetic stage at which language was acquired than two years. The second year, however, is the year of language acquirement in the majority of cases recorded.

with some children, much later with others, as may be seen from the table that follows; but it comes about always in the same manner,[67]—first the understanding of verbal symbols, then much more slowly the imitative use of them.

TABLE XIX. FIRST INTERPRETATION OF VERBAL SYMBOLS.

DATE.	OBSERVER.
5th month[67a]	Cooley
6th month	Tilley (1st child), Shinn (niece)
7th month	Tilley (2d child), Hall, Sharp, Darwin, Shinn (nephew)
10th month	Taine, Moore
12th month	Preyer

III. TOUCH.

1. SPECIALIZATION OF SENSIBILITY IN THE FINGERS.

During the early months of life, it is amply evident that the center of touch sensibility is the mouth. For two months after grasping was acquired (5th and 6th months), in my observation, the superior facility of the hands for touch purposes was not realized. None the less, it was all this time utilized in various ways; and even while everything still went to the mouth and the hands remained subsidiary, the slight manipulations that were going on, re-enforced as they were by visual interest, were steadily drawing attention toward hand-touch. The peculiar advantage of the lips in tactile sensibility was also declining at this time, from the increase of sensibility all over the body; touches in sundry places were now noticed with laughter or surprise. The investigation of the body, also, involved movements the mouth was incapable of: the feet and legs were seized on as playthings; the head, neck, and face, touched by chance, were investigated, even to tracing the tongue down to its roots with the fingers.

[67] There is an element in the acquirement of language, that of spontaneous ejaculation, which has little to do either with understanding or imitation of sounds; but of that I need not speak under the head of auditory interpretations.

[67a] This date is certainly precocious; but Perez credits the interpretation in a precocious case to the 3d month! I have not used the date in the table, doubting whether it was a first-hand observation.

By the 7th month the use of the hands for tactile purposes was visibly displacing that of the mouth. The practice of carrying objects to the mouth declined, and the baby when lifted to one's face, no longer put her mouth to it to feel it with lips and tongue, but seized at the hair to draw through her fingers. By the time she was a year old, she rarely put anything to her mouth unless to taste it.

Yet there were recurrences to the mouth-touch in the second year. In these cases, the object was usually first examined (sometimes for many minutes) with eyes and fingers, and thereafter carried to the mouth.[68] This points to what I think is a conceded fact,—that the fingers, though superseding tongue and lips as the touch organ, by virtue of their motor superiority and their co-operation with sight, never equal them in tactile delicacy; so that to the end, when the baby wishes to bring to bear a finer sensibility, he uses mouth as well as hands. I saw a curious illustration of this reference of a perplexing point to the lips, in the 20th month. It happened several times during my color tests that I said to the child, who seemed about to answer heedlessly, "Look carefully," and that thereupon she raised the little color tablet in her hand instinctively to her *lips,* to corroborate sight by touch at its most delicate.[69]

In the 10th month the forefinger tip began to be preferred for nice investigations;[70] before this, the finger-tips were used all together. The thumb and forefinger tip were often used together now, which indicated that the preference was due rather to the freer position of the forefinger than to any inherent superiority; but no doubt that very freedom of position had given it an inherited advantage.[71]

[68] But no doubt in this later mouth-examination, after taste experience has become varied, there is often an intention of trying the taste of the object, as well as the touch.

[69] Here the realization that touch and sight usually give diverse and mutually supplementary reports of the same thing, over-reached itself in the effort to *feel* a color, as at about the same age the expectation that sight and hearing will support each other, in the effort to *see* a sound, p. 193.

[70] Out of this specialization of the forefinger in active touch, I thought, rather than by imitation, grew the gesture of pointing.

[71] Mrs. Moore notices the differentiation of the forefinger, in the 8th month; I saw it in my nephew in the 9th.

All detailed records of infants, without direct recognition of this transference of touch interest from mouth to fingers, make it evident enough that it did take place, for notices of the mouthing of objects gradually give place more and more to notices of the handling of them.[72]

2. FINENESS OF DISCRIMINATION.

Although, as I have said, contact sensibility in the fingers never came to equal that in the lips, the greater use of *active* touch made the hands, even apart from the aid of sight, organs of far more finely discriminated perceptions than the lips could give. From the time the fingers were fairly differentiated for touch purposes, therefore, from about the 7th month, an increasingly efficient exploration of the world by means of touch developed. It is impossible, however, to separate most of this from the subject of sight-exploration, since the two senses constantly cooperated. I have noted already how smaller and smaller objects were picked up and fingered,—down to a single hair in the 8th month; and so in other records (p. 147, and note 2). Even by itself the tactile sense of the fingers was used with lively interest; surfaces were explored, and novel ones, as the bark of a tree, the zinc under a stove, perceived with curiosity as unfamiliar. This was especially noted in the last months of the first year; in the second and third years, as experience grew more complex, such simple touch investigations interested less. During the fourth quarter-year the feet as well as the hands were used with much interest for feeling over novel surfaces, a practice which ceased when shoes with soles were put on.[73]

3. INTERPRETATION.

The child's conception of an object, after a fair amount of joint visual and tactile investigation, is made up of presentative and representative elements, visual and tactile. When he feels

[72] Mrs. Wood in the 7th month, Mrs. Hall in the 12th, mention expressly that objects are handled for a while before being lifted to the mouth.

[73] I do not find definite mention in other records of this period of conspicuous interest in investigating surfaces with fingers and soles; but my nephew, in the 9th month, has entered upon it quite as decidedly as my niece did.

it without seeing it, the visual representative element must be added to reproduce the complete object to his consciousness, no less than in the opposite case the touch representations.[74] The recognition of a known object by feeling only, then, is an interpretation, not a direct perception.

As early as the 14th month my niece could recognize my features by feeling them over in the dark. At two years old, and several times in the third year, I found her able to identify the several solid forms thus (I, pp. 70, 103). The experiments excited great pleasure in the child: it was especially interesting to her to identify an object by touch, then to look at it, thus comparing the testimony given by the different senses, and to a certain extent analyzing back into its elements the old synthesis of her earlier babyhood. I know of no other observation on the subject, but I have no doubt other children would show the same facility.

IV. MINOR DERMAL SENSES.

1. PAIN.

This sensibility remained low throughout the second year, at least; in the third, it increased, but still seemed less than in an adult. It is true that the severer hurts caused violent distress (so far, at least, as the vigor of the crying reaction is an indication). But the transitoriness of the distress was remarkable; up to the 20th month there was no sign of pain after its first infliction, though the injury of the skin remained. Even burns caused little discomfort after the first. The nerve ends seemed to recover normal condition with a rapidity impossible in the adult skin. Nevertheless, pains could not have been altogether forgotten, since caution was soon learned from bumps in the early creeping, standing, and walking; and the child was readily taught by a little gentle pricking not to desire scissors and the like.[75]

Slight pains were easily subordinated by mental interest; thus in the 24th month, the child actually tried to make the dog

[75] The same thing was noted by Mrs. Hall and Mrs. Moore.

tions are really tactile-motor ones, as all the visual ones are really visual-motor ones.

[74] The same thing was noted by Mrs. Hall and Mrs. Moore.

snap at her and graze her hand again, for the gratification of curiosity over the process (I, p. 149).[76] Indeed, the pain feeling in itself excited more than any other a curiosity, self-consciousness, and disposition to dramatize (second year). Its influence in defining the conception of self must have been great.

Pain perceptions seemed more subject to suggestion than any others (second year); but there was more effort on our part to bring them under control of suggestion.

I find practically no notes concerning pain in other records, beyond the few cited in footnotes; so far as they go, they are wholly in accord with mine.

2. TEMPERATURE.

I never saw in my niece any sensitiveness to atmospheric cold or heat such as adults feel very quickly; but extreme changes she would of course have felt. Local cold touches would no doubt have been felt at any time, but I have no note of it before the 17th month. The child did not at any time show the dislike to taking cold liquids into her mouth that some children do. A cooler temperature was enjoyed in the bath than seems to have been the case with Preyer's child;[77] I find no other reports of the temperature used in bathing.

[76] Tiedemann records that in the 5th month the least change made his son forget "even a toothache" (*op. cit.*, p. 24); Mrs. Beatty, that a visit to the kittens would stop the hardest cry over a bump or the like. Mrs. Hall's boy, in the 8th month, having accidentally hit himself with the handle of a brush, " with a force that made him wince, repeated the motion many times, wincing each time that he made it, although he did not succeed in hitting himself," *op. cit.*, p. 531; see also a similar experiment in pain on p. 534. Mrs. Tilley found that her second boy, in the 29th month, could not be diverted by pain from the forbidden pleasure of turning on water: "I have spatted one hand *very hard*, and while I was doing it he reached for the faucet with the other." See also Mrs. Moore, *op. cit.*, p. 81. My nephew, up to 9 months old, has seemed as indifferent as other infants to slight skin pains, so long as there is no element of shock; a really deep stab from a rose thorn he received in the 7th month with little concern, but cries readily at the slightest bump or blow.

[77] Preyer's child was bathed at first in water of 36° C.; in the 7th month, when the water was from 34 to 35, he always grew pale, as if from a shock to the circulation; he took pleasure in the bath, however, until it was lowered (the note is not dated) to 31¼, when he screamed uninterruptedly till the water was made warmer, and this seems to have been the case till the third

By the 20th month she discriminated moderate differences in temperature readily by the touch of the hand.[78] The temperature perceptions seem to appeal early to the child's attention, and to reach verbal expression, for no other descriptive adjectives are so uniformly early in appearance as hot and cold, warm and cool, in all the vocabularies in my hands.[79]

V. TASTE AND SMELL.

1. TASTE.

Growth in Keenness of Sensibility.—The dullness of taste sensations in the early weeks of life has already been spoken of (pp. 37–8). Until the period of weaning, in the second half-year, there is little opportunity for the infant to develop or to display any finer sensibility. From the second month, my niece showed a certain surprise, or shock to habit, in experiencing a novel taste; and from the 5th month, on little tests, showed now and then pleasure in a taste. Other records[80] give instances of pleasure in some taste,—possibly depending only on the degree of sweetness. But on the whole, there is no indication that dur-

year (*op. cit.*, p. 115). My niece was bathed from birth in water of about 35½° C. (96° F.); this was lowered within a few weeks to 34° C.; by the 6th month to 32° C.; by the middle of the second year, I find 31° C. noted as the regular temperature, and a reduction of this one day, by a chance failure of hot water, to 26½°, though it was not liked, was accepted without repugnance. The bath was always enjoyed, and never produced any but pleasant circulatory effects. So far as I know, the temperatures of her bath were such as are usual with American babies.

[78] Mrs. Cooley and Mrs. Tilley both note the same thing.

[79] To add a word on other dermal feelings:—

The few notes I can find on the subject show infants sensitive to tickling at whatever time the test is made; so in the 3d month, Tiedemann, Mrs. Tilley; 17th month, in my own notes. The feeling delighted my niece intensely at this date; in later childhood, it was disagreeable, as to almost all children.

Wetness and dryness were distinguished by the hand from the 19th month, and the concepts intelligently named.

[80] Tiedemann, Mrs. Tilley, Mrs. Helliwell. Sigismund, however, at the beginning of the 7th month, says: "The exercise of the sense of sight excites livelier pleasure than that of taste. The child still expresses no joy over good tastes." *Op. cit.*, p. 41.

ing the nursing period taste sensations are of much interest or importance to the child, as compared to other sense experiences.[81]

After weaning, children are sometimes reported as making difficulties about foods, refusing one and accepting another.[82] There seems no reason for such discriminations, except taste preference. But it is not consistent and decided preference, and I cannot help thinking that there is some element of organic demand about it. When one food is rejected, and another preparation differing not materially in taste is accepted; when the same food is desired in one month, refused in another, and returned to in a third, as was the case over and over with my niece, (see dietary, I, pp. 230–234), it does not seem a question of taste preference proper. Nor was it a case of whim; the child did not refuse one thing in order to ask for another, but simply lost appetite and weight till some change was made; or, upon the addition of a new article of diet, appetite for others, which had flagged, would revive. Two instances only of real dislike for

[81] The impression that the nursling shows a lively taste interest (Preyer, *op. cit.*, pp. 249–251) is no doubt due to the imperative *food* desire shown by babies from the first—which is not, however, evidence of taste enjoyment. The child's persistent habit of carrying things to the mouth has also had an influence. I have already, under the head of Tactile-Motor Associations, given an altogether different explanation of this habit. At the risk of pressing a point already clear enough, I here add some direct considerations against the taste-association theory.

1. The natural motor association of the nursling with food is not that of lifting the arm to the mouth, but of being put at the breast. From the first, the arm movement upward has been followed by the presence in the mouth of objects that gave the tactile-motor pleasure of sucking, but no taste pleasures.

2. If the infant had nevertheless some dim expectation of food, in carrying objects to his mouth, he would not go on day after day sucking inedible rattles and spools, but would show disappointment. Associations of pleasure do not persist when in the great majority of cases the action fails to yield the pleasure.

3. The infant does not treat the objects carried to his mouth as if they were food; there is no intentional swallowing; the object is instead mouthed and mumbled about over the delicate touch surfaces of lips and tongue, and especially is sucked.

Undoubtedly the ancestral association of the tactile surfaces at the mouth of the alimentary canal with the choice of food, is at the bottom of the whole habit; but that antedates the specialization of the taste sense itself.

[82] Sigismund, Mrs. Moore.

any taste were noticed in the first year; almost any article of food while novel was liked.[83]

Up to about the middle of the third year, indeed, while some tastes were greatly liked, none seemed to be much disliked; after this, the child became more discriminating, and many things were refused.

Taste desires were as a rule easily subordinated by other interests, and were quite readily inhibited. Curiosity and experimental interest connected with taste was slight. Nevertheless, from the 8th month up to the last quarter of the second year, great joy and desire were often displayed over tastes. How far my observation corresponds in this to that of others, I have not the data to judge.

Special Preferences.—Some of the special preferences recorded seem to me significant enough to be mentioned here. I found sweetness not especially liked before the 16th month. Milk seems never to have given much taste pleasure, and to have been desired in the nursing period mainly or altogether for the satisfaction of hunger. Clear salt seemed not to be perceived by taste at all up to the 9th month, but after this, especially in the 15th month, the child was passionately fond of it, preferring it to sugar,—a preference which I am not the only one to note.[84] The most consistent liking was for fruits, and here fruits of somewhat lively acid taste were preferred to the merely sweet ones; even clear lemon-juice was desired, from as early as the 9th month. Meat was liked next after fruit during a considerable part of the second year. Oily tastes, as of nuts and olives, were liked; and also strong ginger.[85]

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[83] "He often refused a food that had at first seemed agreeable to him." Mrs. Moore, *op. cit.*, p. 83.

[84] Mrs. Moore's son showed liking for saltness in the 12th month. In the 18th month, "he liked salt greatly, and would have eaten it by the spoonful; sugar he refused to eat, but he liked to play with it. Throughout the second year he continued to like juice of oranges, grape fruits, or lemons (the last in lemon jelly), also apples and grapes. He did not care for sweets, but continued to demand salt." *Op. cit.*, p. 83. In the third year this child returned to liking for sugar. My nephew in the second half-year shows about equal liking for salt and for sugar.

[85] Mrs. Tilley and Mrs. Cooley record great liking for peppermint. There

Now these preferences certainly point to a somewhat dull sense of taste, desirous of strong stimulation. Older children are usually averse to strong flavors. It is true that my niece's preferences were all in themselves like the father's or the mother's, but neither of them would eat pure salt, or suck a lemon undiluted; nor would the child herself, after the second year. Indeed, from the third year there has been nothing unusual in any of her taste preferences.

2. SMELL.

I have said above that the early functional perfection of the smell apparatus, central and peripheral, and the unquestionable capacity of reaction to smell stimulus from the first, is hard to reconcile with the apparent absence of smell perceptions for many months. The proximate cause of this contradiction seems to be the failure of *active smelling* to develop, and the ultimate cause the declining importance of smell to the human race.[86]

is really as much record of liking for such strong flavors to be found as of liking for sweetness; but I have no doubt this is because liking for sweetness was taken for granted. Still, when we consider also that apart from mere food desire there is usually indifference to milk, we must feel that Professor Preyer has rested too much upon the "sweetness of the mother's milk" as an explanation of the baby's choices, associations, and movements. I do not question, in face of all the independent evidence from all times of life, from language, from comparative physiology, that sweetness is really the most universally attractive taste; but rather that taste itself is developed to any keen sensitiveness in the early months of life.

I may mention as an additional evidence of the late development of discriminating attention to taste, that no vocabularies of two-year-old children show specific taste names. "Good," or some equivalent word of general approval (descriptive, as Professor Sully says, of the child's feeling about it, rather than of the quality itself), appears about the middle of the second year, as a rule; and a little later some word of disapproval.

[86] The links of cause and effect between ultimate and proximate cause can be traced back, in a negative way. Involuntary sniffing does not take place, to bring the stimulus to the olfactory nerve ends; even if it did, there is no reason to suppose that the sensation would excite hedonic impulses, and so lead to the repetition of the act, and the establishment of smell associations,—for there is no appearance of hedonic feeling connected with such smells as do, by their own diffusion or by artificial experiment, reach the nerve-ends. To go a step farther back, the sniffing movement does not take place automatically, because the ancestral paths are not well worn,

Yet smell does not altogether conform to the description of a disappearing sense, or a survival; as such, it should appear in the young infant, and fade out later. A complete study of its history among the primates might give us some light on its status in man.

My niece showed no sign of smell perceptions until the tenth month, and but doubtful indications thereafter. Like most children,[87] she was taught to sniff at flowers before the end of the first year, but if she really did manage to inhale the smell, she cared nothing for it, and made no distinction between flowers with and without perfume. At the end of the 18th month, she suddenly showed herself well able to recognize certain decided smells (wintergreen and camphor) and probably had been able for some time, but had showed no interest in the perceptions. It was not till the 33d month that she seemed really to find a smell disagreeble, uninfluenced by suggestion. (I, pp. 174–6).

Professor Preyer found evidence of true smell perceptions, on ordinary stimulation, from the end of the 15th month, and Dr. Garbini dates them from about the same period.[88] Other observers seem not to have seen such evidences at all within the first three years, but this was no doubt for lack of special attention to the matter.

Meanwhile, while the infant seems so obtuse to odors from without, which require inhalation, we must remember that he is probably experiencing more or less smell sensation through

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so that jets of excess motor energy tend to them, as to the motor paths for the eye, the mouth, the neck, the arms. Thus, while the development of active sight and active touch is automatically initiated, that of active smell remains latent, with all the nervous apparatus ready.

[87] So in the records of Professor Preyer, Mrs. Beatty, Mrs. Tilley, Mrs. Daniels. The valuelessness of this sniffing for olfactory purposes is evident from the child's own ignorance of its meaning. My niece at first confused it with kissing, and would sniff at the picture she had been taught to kiss, and put a flower into her mouth. Preyer's child sometimes exhaled instead of inhaling, or put the flower into his mouth. Mrs. Daniels's daughter would sniff at any new colored object (14th month). Mrs. Tilley's boy, as late as the 24th month, had not learned to smell, and would put his mouth to the flowers. It is not from lack of effort to teach that these children failed to grasp the idea of smelling.

[88] Evoluzione del Senso Olfattivo nella Infanzia, p. 20.

the rear passages, from his food. Probably this happens from the first, in taking milk;[89] and that smell sensations are not only received but discriminated, is certain from the time a liking is shown for peppermint,[90] or other such substances, if we have made certain that it is really the characteristic flavor and not the sweetening that is liked. When meat broth is first enjoyed,[91] smell sensations must be involved. However, the baby, like adults, does not distinguish sensations of smell received through the rear passages from those of taste, and no clear olfactory perceptions are formed.

VI. SENSES OF MUSCULAR ACTIVITY, MOTION, AND EQUILIBRIUM.

1. MUSCULAR ACTIVITY.

It is futile to trace the development of muscular feelings as a separate topic. In the advances of visual and tactile discrimination already spoken of, the real advance was as much in fineness of muscular feeling, and in its constant association with sensations of light and of contact, as in increasing sensibility to light and contact in themselves. In learning to stand, walk, climb, jump, and perform all the movements of bodily management, during the second half-year especially; in the acquirement of spoken language in the second half-year and thereafter (and for that matter, in the temporary use of sign-language, which is an important stage); in the acquirement of hand-skill, which is quite visible by the third year,—the muscular sensibility must develop steadily in fineness, and enter into most elaborate associative relationship with equilibrium feelings, with hearing, and with many complexes of sight and touch. But all this is familiar ground to analytic psychology: and any contribution that a record of observation could give to the subject would be nothing less than a history of the development of movement and of language.

In the infant's own consciousness, as in his visible behavior, the muscular sensations are no doubt lost in the complexes of which they are the uniting element. The release of the muscles

[89] Garbini, *op. cit.*, p. 18.

[90] Second month, Mrs. Tilley.

[91] Eighth month in my observation.

from restraint was in my observation perhaps the earliest pleasure, and their free activity the greatest joy of the first year, if not of the first three years. It is scarcely possible, however, to separate the purely muscular pleasure from the diffused feelings of exhilaration coming from organic and vascular conditions. In the intense dislike to being caught or held, which I have fully related in my published notes (I, pp. 182–188), there was no doubt, as I have there suggested, more than mere sensory discomfort. In the joy of achievement shown by the child over the accomplishment of any muscular feat, also, we have to see more than mere sensory pleasure.

Yet the centers of muscular sensation, no doubt, like all other sensory centers, crave discharge by their appropriate stimulus, and experience a purely physical joy in the release of this tension.[92] When a baby shows delight in a single act of muscular exertion (as in an instance cited by Tracy from Canfield, when a child in his 4th month held up his toy rabbit by the ears, crowing with pleasure; see also I, pp. 189–90, 192, for instances of the liking for a feeling of weight, or for pushing or pulling against an obstacle), we get very near to this primitive, simple muscular pleasure. When a baby experiments with his own body, trying new positions, getting comparatively unused muscles into action (I, p. 198, and scattered notices 324–96), the element of mere muscular enjoyment sometimes predominates greatly; the child is not trying to see how the attitude or movement in question looks, nor what it will serve for, but merely what he can do with his muscles. Much of the progress in locomotion came in my observation from such aimless muscular experimenting. The pure feeling of muscular activity seems to have been differentiated to consciousness most

[92] How far the tension occurs in the sensory center of muscular feeling, and how far in the motor cells themselves, is a question for brain physiologists. At a guess, one would say in both; and that this enormous re-enforcement of central demand may be what makes the craving for action more imperative than the hunger for light or for sound, the joy in pure activity greater than that in the passive reception of any sensation can be, and the addition of the element of muscular sensation to any sensory complex necessary, before it becomes a source of great satisfaction to the child.

distinctly in any *novel* movement, and to have become neutral and indistinguishable (as with us) when the movement became familiar. So, too, the early use of the adjective "heavy"[92a] shows that a sensation of *difficult* muscular exertion, the feeling of weight, is early recognized.

It is hardly necessary to fortify my own observations on such a subject with citations from any other records. Children evidently vary in the *degree* of their delight in muscular activity, and in the proportion it bears to passive sensory pleasures, or to intellectual activity; but not in the fact of it. There is also some variation as to preference for large and vigorous muscular exertion, as in running, shouting, and capering, or for fine and skilful use of the muscles, as in picking up and laying down tiny objects, corking and uncorking bottles, etc. In the former case, organic and equilibrium feelings enter largely into the pleasure; in the latter, more or less intellectual element. I have not data enough to make any intelligent comparative study of these differences in children; and indeed, it would carry me far beyond the limits of my subject.

2. PASSIVE MOTION.

During the first half-year I found the pleasure given the baby by passive motion greater than that of muscular activity; even when her face was covered, so that the motion feeling must have been quite unmixed, it pleased her (I, pp. 200–201). Later, this relation was reversed; still, throughout the whole period under review, to be swung, tossed, etc., was pleasing. During the early period, a monotonous jarring was more quieting than smooth motion; and later, especially from the 6th month on, sudden jolting caused merriment. I have observed in general that healthy children do not experience the unpleasant sensa-

[92a] Tilley (older boy), 20th month; Gale (youngest child) and Shinn, 22d; Gale (second child), "before the 23d month"; Holden (both daughters), by the 24th month.

My niece used "hard" as an adverb as early as the 20th month, and both Mrs. Moore and Mrs. Price record it in the vocabulary at two years old, but I am doubtful whether it expressed consciousness of a feeling of muscular effort.

tions from jar that adults do, though unexpected jars frighten them. Yet children vary a good deal in this.[93]

3. EQUILIBRIUM.

Feelings of equilibrium, present from the first, are most evident in the period of learning to stand and walk. All children show a consciousness of insecurity in balancing, before they have had any opportunity to learn fear by falls; and this "timidity" can be credited only to the disagreeable feeling of disturbed equilibrium. They all show delight, too, in achieving the feeling of secure balance.[94]

My niece never showed any feeling of dizziness; nor have I found it reported in any record. Movement that would have made an adult dizzy was enjoyed (I, pp. 209–10). In later childhood,—at six or seven years old,—dizziness could be produced, but still was not felt as disagreeable; and this I think is the rule, with healthy children.[95]

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[93] Mrs. Tilley's and Mrs. Moore's children, in the 3d month, started and threw out the arms, cried out, or in other ways showed themselves startled, at a lurch or jar in driving, or in riding on the cars. My niece was quite without such sensitiveness to jar. Similar individual differences come out strongly in the acquirement of locomotion, when some children dread falling very much, and others are quite indifferent to it, unless actually hurt. Thus my niece, in the 10th month, while still unable to stand alone, would let go the chair she was holding for the pleasure of coming down sitting with a thud, and repeat the play over and over; and another little girl, daughter of Dr. Mary Stevens, of Detroit, enjoyed pulling a rocking-chair forward so as to let her sit down hard, and would appeal to her mother to help her up and let her do it again.

[94] Instances of unmistakable feeling of equilibrium disturbance in the newborn have been cited, on p. 42. During the early period of sense development, the painful feeling, like fear, when suddenly lowered, or when put into the bath, continues to appear in some children (see notes of Tiedemann, Mrs. Hall, Mrs. Moore, Mrs. Meade, Mrs. Tilley); but agreeable equilibrium feelings also appear in learning to hold the head and the back erect.

[95] To this chapter I may add that complex feelings of position, made up of muscular and equilibrium sensations, sensations of organic weight and skin pressure, and of vascular sensations, are to be observed in any baby, almost from the first. Fatigue readily makes itself apparent in connection with position; and before the infant can move himself at will, this is important to the nurse. Later, fatigue in one position is a powerful stimulus to the child in learning movement and the management of the body. The feeling

VII. ORGANIC SENSATIONS.

1. HUNGER.

It is hardly necessary to say that in every nursery, in the early period of sense development, hunger is a dominant sensation. It ranks only with pain in its insistence while present, and like pain, seems to disappear from the psychic field entirely the instant it is removed, leaving none of the memories, feelings, and desires that other sensations do.[96] I saw no disposition to take food except when hunger was actively present.

Yet even in the early months a strong sight impression could divert my niece from hunger,[97] while no effort could divert her during intense absorption in a sight impression. If hunger lasted long enough, however, to affect the general organic condition, through defective nutrition, the discomfort suspended every special sense interest (I, p. 217); on the other hand, the general sense conditions resulting from good nutrition were perhaps more productive of joy than any special pleasure, besides enhancing all special pleasures.

After the sixth month, as a rule, hunger ceased to have the imperative quality, and could be easily overshadowed by desire of seeing, hearing, and doing (I. pp. 221–3, 224–5). The organic effects of good nutrition were no less important than

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of position, also, taken in connection with visual observation of his own body, must play a considerable part in developing clear somatic consciousness.

It is noteworthy that it was such a position complex of sensations that was first represented, and entered into associative relations, not any specialized sensation (p. 54).

[96] Yet the early psychic importance of the sensation is evident, since it was the basis of the first representation and association (p. 54, and note 95, above). The next visual recognition after that of a human face is the breast or nursing bottle (p. 68).

[97] So also in notes of Prof. Preyer, Mrs. Tilley, Mrs. Cooley, Mrs. Helliwell, and Mrs. Beatty. In the case of my nephew, who was born a thin and hungry baby (while my niece came into the world plump and well nourished), hunger was for several months most tyrannic, and his cries for food were like cries of pain; but as soon as good conditions of nutrition were established, and his weight up to a fair average, sight and sound impressions became more interesting than food to him also, and it was often hard to get him to attend to his bottle (3d quarter-year), and leave his play.

before; and the immediate sensation of satisfying hunger was sometimes, especially in the second year, a lively joy; but on the whole it was far from taking a leading place among the child's interests.

Individual differences are no doubt great here. It may be that a robust and tyrannical appetite shows active metabolism, and is a sign of vigor in the child; but my own observation tends rather to indicate that in a normally well nourished child, under normal conditions, the food craving by no means ranks as high in consciousness as the craving for muscular, visual, and auditory activity.[97a]

Questions of how much, or how often, or what a child should be fed, to be "normally well nourished" belong to the province of dietetics, not to that of psychology.

2. THIRST.

That thirst is a remarkably strong craving during the whole period under consideration, every one knows who has ever tended a little child. After the milk diet ceases, the demand for water is enormous, and I noted no decrease in this up to the end of the third year. If the normal proportion of water in the infant's body at birth is about 75 per cent., and decreases very slowly from this to the adult proportion, 58½ per cent.,[98] while the evaporation due to the porous skin and constant activity is much greater in the little child, it is evident that thirst must be a perpetually recurring condition.

3. NAUSEA.

As Preyer observes, nausea does not accompany the regurgitation of milk in the early months. But after weaning it occurred several times, in my observation; once as early as the 10th month. By the 19th month, the child located the feeling fairly well.[99]

[97a] P. 221. See also "The Comparative Importance of the Senses in Infancy," M. W. Shinn, *Northwestern Monthly*, VIII, 9, April, 1898.

[98] Fehling, cited by Oppenheim, The Development of the Child, p. 13.

[99] I, p. 235.

A few words regarding choking, suffocation, and organic pain, will be found in I, pp. 235–6.

VIII. GENERAL SENSATION.

1. TEMPERAMENT.

Individual differences between babies are strongly marked, even from the first months, in the matter of the underlying sense condition of pleasantness or unpleasantness, equability or variableness. This is quite evident in going over the different records in my hands, though it would not be possible to illustrate it without copious quotation.

In my niece's case, the undercurrent of feeling seems to have caused a stable cheerful condition, which reasserted itself quickly after disturbance by specific unpleasant impressions; during the first year, it often rose to great joyousness without definable cause, but this was somewhat less evident in the second and third year, as the increasing variety of specific pleasures absorbed the faculty of enjoyment into themselves, so to speak; and the child's temperament in later years was evidently one rather of equable cheerfulness than of the exuberant joyousness associated with the time of most rapid growth and development. In the case of some other infants, the underlying condition is evidently less stable, and yields even more readily to pleasant stimulus, giving a higher degree of joyous excitement, but is also very easily disturbed by unpleasant experience, and is more liable to after reverberations from joy or distress; this temperament is very evident, from the earliest months, in some of the records. In still others, an undercurrent of discomfort seems often present, even when it is not possible to find direct physical cause.[100] Nor do these differences depend on traceable differences in physical health; rather, one may conjecture, upon some condition of permeability in the organic nervous system, by which disturbances are more or less diffused, and therefore affect obscure organic conditions more or less. It is possible that these individual traits of temperament remain constant throughout life; I have seen some cases (where the infant temperament is on record, and accords with that of the mature person, as known to me), which indicate that they do; but I have no data to justify generalization.

[100] One cannot help being struck with the correspondence of these distinctions to the old empiric classification of temperaments as sanguine, mercurial, and melancholic.

2. MOODS.

Fluctuations in the baby's feeling of general well-being are noticed in all records. In my own, long waves of mood are apparent after the first year,—waves lasting for weeks or months, and but imperfectly traceable to any cause; and shorter waves, sometimes mere ebullitions of gayety or fits of peevishness, within these. The shorter moods were evidently connected with dentition; the appearance of a tooth was apt to be followed by an ebullition of gayety. I thought it probable that the longer periods had also some connection with dentition; but psychic conditions had more to do with them,—the child's growing desire for interest and occupation now outstripping her ability to provide it for herself and making her restless and exigeant, and again opening up to her new fields of pleasure and activity, and ushering in a period of happiness (I, pp. 237–249).

I cannot follow these fluctuations in other records; but some variations in mood appear in all records as the result of obvious causes. The uniform effect of the bath (I, p. 249) in heightening the child's merriment, vigor of innervation, and even mental activity, is no doubt due to the freedom of the limbs, and the effect of the immersion upon circulatory conditions. Even more remarkable was the exhilarating effect of the open air, and other outdoor conditions (I, p. 250, *et seq.*),—an effect beyond what can easily be accounted for by the physical influence of the air, and any definite outdoor pleasures and occupations. Nothing in all the child's development tempts the observer so much to theories of vague ancestral reverberations, as the remarkable and overshadowing desire to get outdoors, and the endless contentment there, like the satisfying of some dominant instinct that is thwarted indoors. This may not be so conspicuously true in every case as in my niece's, but it is more or less evident in all records.

3. CONDITIONS ATTENDING SLEEP.

I found marked alterations in mood and emotion at the coming on and the going of sleep, which I could only attribute to vague and widely diffused changes in the sensory condition.

The well-known fretful condition of "sleepiness" was seen all through the first year, after the first month. This is not the sensation known to us as sleepiness, or drowsiness, and localized somewhat vaguely about the head and eyes; but a condition of general sensation more like ours in insomnia, when we have lost sleep, yet cannot experience a normal drowsiness; it appears in the baby, probably, because the time habit in going to sleep is not yet established, and drowsiness does not appear when it is due, although a general nervous fatigue has already set in (I, pp. 260–261).

From the middle of the 5th month, there was evident a strong resistance to sleep (I, pp. 272–8), which was at first plainly due to a desire to play; but later, by the 11th month, seemed to come from feelings of loneliness and timidity connected with the approach of sleep. From this date increasingly throughout the whole period under consideration, the disposition to confidence and affection, the sense of dependence, was peculiarly developed at bedtime (I, p. 278). This, I think, is frequently noticed.

Waking from sleep, when the sleep had been sufficient, was followed in the early months by a period of high good temper; but later there seemed a peculiar susceptibility at this time to feelings of timidity and loneliness, an unaccountable sort of distress (I, p. 279 *et seq.*). After the 7th month this was so marked that I was satisfied that some peculiar conditions of self-consciousness are associated with waking, probably a disturbance of the feeling of bodily identity and of relation to the external world,—feelings as yet but feebly established, and liable to confusion from alterations in cerebral circulation. Throughout the second year, and for some months in the third, this condition was often very noticeable, amounting sometimes to fits of wild crying and distress. It appeared also in the unaccountable crying at night that is called "night-terror" by medical writers,—not terror, it seems to me, but a peculiar diffused distress, which may easily be caused by feelings of lost identity, aided by the darkness. I have described it quite fully in the text of my notes (I, pp. 285–7), but I have no comparative material concerning it.

IX. RECAPITULATION.

I do not find that the data of Part III lend themselves well to tabulation. The developments recorded no longer proceed by a series of significant steps, as in Part II, but by long, unbroken processes, tending imperceptibly to a result. Thus a tabulation could only record growing clearness in visual definition for months, growing sensibility to pain, gradual acquirement of size and distance interpretations by an infinity of daily experiences; and so on. Such processes I can present most clearly in mere recapitulatory paragraphs.

I use my own observations as the basis of the statement, but I generalize and check them as far as possible by those of others, as in the recapitulation at the close of Part II. In cases where I have not had comparative data, the chronology of the summary will be liable to correction.

1. SENSORY CONDITION AT THE CLOSE OF THE PERIOD OF SYNTHESIS.[101]

Intensity and Differentiation of Sensations.—Great joy is experienced in the sight of motion, light and shade, but it is doubtful whether color vision yet exists. Visual definition is poor, and tactile delicacy in the hand undeveloped, so that no objects under perhaps an inch diameter are noticed or grasped. Visual adjustment is slow; the movements of people walking about are followed, but no smaller or quicker movements. There is no effort to handle objects (though some children investigate surfaces), and the hand is used only to carry them to the mouth.

Sounds are heard fairly well, and somewhat differentiated; music affects the child agreebly, and sometimes suggests a responsive cooing; the human voice is in a general way discriminated from other sounds, though individual voices are not recognized; extremes of pitch and marked differences in quality of tone have in some cases a strong affective quality; even spoken syllables are now and then noticed as pleasing or amusing.

Sensations of pain, of diffused temperature, and of taste are dull; but instances do appear of likes and dislikes in taste. Active smelling does not appear, and if any smell sensations are

[101] About the beginning of the 6th month.

received it is through the rear nasal passages, undistinguished from taste.

Feelings of muscular activity give pleasure, still more those of passive motion; a monotonous jarring is especially soothing. Some children in the early months are distressed by sudden changes in motion, and very sensitive to equilibrium disturbance; others scarcely at all.

The hunger-thirst feeling is imperative in quality, yet easily suspended by appeals to eye and ear. Diffused conditions of general comfort and discomfort are strongly felt.

Recognitions and Interpretations.—Outlines are traced by the eye, and objects are beginning to be identified, by eye and hand. The practical difference between seizable bodies and plane figures is just coming to attention, and associating itself with their differences in appearance.

Direction and position, within the visual field, are well enough systematized. Distance has some measurement by accommodation movements, by the arm-reach, and by passive movement to and fro; but its relation to changes in apparent size, or to the advance and retreat of bodies, is not understood. Beyond the visual field space relations are conceived only through the most fragmentary and crude inferences from experience.

Sound is well associated with the expectation of sight; and when near by and in the horizontal plane of the ear, or when familiar to experience, with the visual direction. The processes of producing sound begin to interest.

There is fair somatic consciousness of face and hands, and a rough knowledge of the rest of the body.

2. SIXTH MONTH.

A sort of transition period; the fusion of hand and eye consciousness is in progress, and the new type of experience not yet fairly established. Instead of systematized conceptions of lines of movement in space, we get glimpses of the crudest empiric expectation that bodies will appear here or there; and solidity is still only seizability. The use of the hand as a touch organ is increasing, however. The promptness of visual adjustment

is greater; the hand movements of others are closely watched, and much thus learned of direction and position in space; the movement of falling bodies attracts attention at about this stage.

There is an increase of tactile sensibility all over the body, and the control over it and acquaintance with its surface increase greatly.

There are efforts at locomotion, and motor enjoyment increases. I saw beginning in this month a delight in lively jolting and tossing about.

3. SECOND HALF-YEAR.

Intensity and Differentiation of Sensations.—Reactions to color, at least to the long-wave colors, become unmistakable. The eye adjustments continue to grow quicker, but probably remain slower than those of an adult. The delicacy of visual definition and the tactile delicacy of the fingers increase steadily, till in the 8th–11th months the minutest objects are noticed, picked up and fingered.

From the 7th month the supremacy in touch has plainly passed over to the hand, and by the end of the year the mouth is only resorted to to supplement hand-investigation; in the 8th–10th months the forefinger tip is specialized for minute investigations.

Pain sensibility remains low, and hurts have remarkably transitory effect.

Hearing grows more alert, and there is less liability to auditory shock. Enjoyment of music continues, but is not often intense, and only the most precociously musical children acquire the least mastery of rhythm or pitch within the year. The differentiation of sounds to the ear increases wonderfully.

With the adoption of more varied food after weaning, more taste interest appears; sometimes great pleasure in tastes, but I saw no decided dislikes. Indications of smell are most doubtful.

Feelings of muscular activity enter into fine relation with equilibrium sensations in acquiring balance and locomotion. Passive motion is now less enjoyed than active. Sensations of dizziness are not experienced.

Hunger and thirst are differentiated after weaning, and thirst

becomes frequent and intense. Hunger is at times imperative, yet is even more easily suspended by interests of the intellectual senses than in the first half-year. Nausea has been observed by the 10th month. General sensation still supplies dominant undercurrents of feeling.

Recognitions and Interpretations.—With the acquirement of creeping, which is usual in this half-year, the infant ranges to and fro, handling everything, and rectifying his ideas of distance, size, direction, and position; by the end of the year all these spatial relations must be seen and conceived much as they are by ourselves, and well estimated for a space about the child at least equal to an ordinary room. From the 11th month outline pictures are recognized and suggest the object represented, and in the 12th month a simple plane figure can be readily discriminated and known by name. Solidity is probably perceived as we perceive it, but there is no attention to solid form, and the knowledge of it must be of the slightest.

The fine differentiations made in the hearing of verbal sounds are interpreted with singular precocity, and spoken words begin to be understood usually about the 7th month (in some cases even earlier), and by the end of the year a good deal of speech is understood. Individual voices are recognized and referred to the proper speakers about the 8th month, but few other sounds to their respective sources within the first year. The origin of sounds is investigated curiously through the whole half-year, and intelligent experiments in sound have been reported, 9th–11th months. Sounds in the horizontal plane are more and more perfectly referred to the proper direction, and there is a slow improvement in locating sound above that plane.

With the larger control over the body, and much investigation of its surface and trying of its powers, the extension of somatic consciousness is great. Conditions of diffused discomfort and timidity at the approach and end of sleep suggest a disturbance of general sensation, with confusion of somatic consciousness, and more or less loss of the still unstable feelings of personal identity, and relation to the exterior world.

4. THIRD HALF-YEAR.

Very early in the second year (13th month) consciousness of light and dark appears in language, but no one has been able to find comprehension of any color concept before the 16th month, nor of any except red before the 17th; about the 18th, color associations appear. Visual discrimination for outlines, however, becomes remarkably fine, as good as that of any untrained adult. Features are recognized in the smallest photographs; letters and characters are learned with the greatest ease and spontaneity (12th–16th months). Pictures, oftener strong outline pictures than colored ones, are of great interest from this half-year on.

Interest in the origin and interpretation of sounds remains lively, and most sounds now come to be referred to their respective sources.

Well developed smell perceptions, discriminated and recognized, appear in the latter part of this half-year (15th–18th months).

5. FOURTH HALF-YEAR.

In this half-year some children can learn to distinguish and name all the colors, as well as any adult; probably they see them as if somewhat less saturated. All the plane figures are easily taught at this time, well understood and generalized. The child when taught color and plane form becomes very observant of them in the world about him. Solid form is taught with difficulty, and does not lead to spontaneous interest.

A few children in this half-year can keep time to music, recognize an air, give a note or interval correctly, or even sing a fragment of an air. Some who cannot, sing spontaneously in a rude chant. Sounds coming in vertical direction are located with more difficulty than an adult experiences; but the direction is accurately caught in the horizontal plane, even if the sound is a distant one; and distant sounds are distinguished from near ones. When perplexed by an unaccounted-for sound, as an echo, the child shows confusion as to the nature of sound, perhaps tending to conceive it as visible or tangible.

Taste pleasure is sometimes lively, but decided choices are not shown. Taste excites little curiosity, and taste desires are easily

inhibited, in some cases, at least, where the habit of inhibition is formed.

Temperature differences, and wetness and dryness, are well discriminated by the hand early in the half-year.

The subordination of pain by mental interests increases throughout the whole second year; yet the sensation is not quite so transitory in the latter part of the year as before. It makes a peculiarly vivid impression on the mind in the form of curiosity and a dramatizing, self-conscious interest, which appears to be closely related to a developing clearness of the somatic consciousness.

A hint of the completeness reached by that consciousness by the fourth half-year is given, in the correct location of the feeling of nausea (19th). The features and members of the body are easily named by children by the end of the second year, as well as the acts of seeing, and later of hearing.

6. THIRD YEAR.

Children who have not yet come to a complete knowledge of the color concepts always prove able to do so in the first half of the third year. Solid form is still not very interesting, but can readily be taught. The space around the child to which systematized ideas of distance and size have extended is very much larger,—perhaps a mile, but this depends on his experience of walking and driving about.

Musical development advances slowly, and some children now first become able to keep time, take a note, etc.; but probably in average cases there is but the rudiment of this before the fourth year. Primitive spontaneous chanting is sometimes quite highly developed. Rhymes and jingles please by their rhythm.

Taste is more discriminating, dislikes more apparent. The child becomes able to distinguish and name all his sense impressions. There is little sense development left to record; apart from the common musical deficiency, and some errors in interpretation through inexperience, the child even at the entrance on the third year has practically the same senses as an adult, and it is the intellectual development based on their report that henceforth demands the observer's attention.

7. COMPARATIVE IMPORTANCE OF THE SENSES.

There is one more recapitulatory word to be said, and it bears not only on this Part III, but on the whole history of sense development from birth: It is worth while to notice the comparative part played by the senses in the infant's psychic life; the demand made upon his attention and interest by the higher and lower groups of sense experiences respectively.

An observer's first impression of a young baby is that in the intervals of sleep he lives only in the sensations connected with food,—hunger and taste. It is easy to think of him as living (vegetating, even Professor Sully says) in a neutral and scarcely conscious comfort, varied only with the liveliest sensibility to hunger, or at intervals, to pain, and but dim sensibility of any other sort, unless it be taste. I cannot make my observations agree with this conception, though I started out with it.

It is true that hunger and pain have in the infant, as they have in us, a quality of imperativeness that can subordinate everything else. But they have this quality in no higher degree in the first month than in adult life. Moreover, in the case of a healthy, well-fed baby, hunger rarely passes the stage of appetite, and there is no occasion for serious pain; and as these sensations, entering little into association complexes, are hard to bring back into consciousness in the form of memories, desires, and fears, the total share of the baby's attention occupied by them is small.

On the contrary, an incessant stream of visual and tactile and muscular and auditory sensation flows into his consciousness during his waking hours. And such sensations are by no means neutral ones. I have already remarked that my niece showed in the first two months more enthusiasm over such visual matters as, for instance, a spot of light vibrating on the ceiling, than she ever showed over food in the first eight months, and quite as much distress over being obliged to lie down when she wished to sit up as she ever did over hunger. The records of others brim with similar evidence.

This relation between the satisfactions of the higher and lower senses holds no less after the child is older, and taste interest has been developed. Children show a keen delight in tastes, but

on the whole not as much, in proportion to other interests, as many adults. The whole apparatus of refined cookery and the production of delicacies, which take up so large a part of the energies of society, are in answer to the desires of adults; indeed, it is largely by living under food conditions fixed by these adult desires that the child develops taste interest. The greediest child, in normal health and activity, does not give as much of his thought to what he eats, or find as much of his happiness in it, as many men of middle life do. The child's prime interest is in his *play*. It was the rule that my niece would rather play than eat, even when she was hungry; and this is a frequent observation in every nursery.

So, also, the interest in play—that is, in the use of the higher sense powers and bodily and mental activities—may constantly be used to divert a child from pain; while the effort to divert him from any play he is set upon by pain is apt to be as futile as in the instance given by Mrs. Tilley of her attempts to keep her boy from turning on the water (p. 200, note).

In a word, the doctrine which has somewhere been formulated, that the infant's conscious life begins with the lowest senses and develops upward toward the higher ones, is wholly contrary to observation. On the contrary, the more extensive the psychic complexes into which a sense enters, by so much the more, from the very first, it leads in the baby's attention,—and in his enjoyment, save only for that delight that comes from a diffused condition of general sensory well-being.

NOTE.—Observations on my nephew, too late to be cited even as a footnote on the proper page, lead me to doubt my generalization that the human voice does not seem to the infant to need accounting for by any movement or impact of objects. This boy shows (end of third quarter-year) persistent curiosity over sounds from our lips, putting up his fingers to investigate, as if seeking a tangible origin for the sound. He is a child given to noise-making manipulation of objects, but not to vocal experiment, and shows little consciousness of his own muscular activities. The converse was the case with my niece. It is therefore quite possible that sound proceeding from human self-activity would early seem normal to the one child, and not to the other.

PART IV. PEDAGOGICAL RESULTS.

The pedagogical results of this study have been to a considerable extent foreshadowed in the course of the preceding record and discussions. They do not formulate themselves into any systematic scheme of sense-education (indeed one of the things that seems to show itself forth most plainly is that nature herself will attend to that in the main); but into a few general principles, which apply really to the education of the little child in all lines quite as much as to his specific sense-training, and a few special suggestions, such as my own observation and study of other records has led to. Sundry others might be made, by other observers; but these are all that are justified here.

In looking back over the whole course of development for the three years, to see where and how the guiding hand of the elder was able to affect it for good, it may be seen to fall quite distinctly into three periods. The first is that before the acquirement of grasping, a period in which the child's senses have not yet come into working order, for lack of cerebral interconnections, and nature must be let alone in completing the sense apparatus by the maturing of the central paths. The second is that period of vigorous eye and hand investigation which follows upon the acquirement of grasping, and in this the parent needs sometimes to lend a helping hand, to give the natural processes their full scope. The third, arising out of the second by imperceptible degrees, and not formally distinguishable from it by any date, is that in which the parent may wisely begin some gentle bending of the formative processes toward the desired goal of education in civilized life.

1. EARLIEST STAGE: BEFORE GRASPING.

Spontaneous Development.—The most constant impression left upon the observer after watching the development of the senses in an infant must be that of irresistible natural processes, which it is impossible to help or hinder to any considerable extent. Suggestions concerning the possibility of accustoming the child

from birth to forms, colors, and motions, presented in orderly succession, fall utterly to pieces before the spectacle of the gradual upbuilding, the knitting together of primitive sensory elements into real powers of perception. Any moderately lighted room into which a baby can be put affords it the material for acquiring vision, and one set of inanimate objects is about as good as another.

The Human Presence.—One thing only seems to be of indispensable value educationally. That is the coming and going of the human face; perhaps (after the first month or two at least) of two or three different faces, with their associations with different voices, different arms to be held in, agreeable experiences of food, and movement, and play.

Nothing in all the infant's environment educates it as does the human presence. In the earliest days of seeing, when nothing is noticed but illumination, the grouped high lights on the face hold the attention with a peculiar interest, and by their fixed relation to each other form the earliest visual association group. The human face bends down and comes to the range of clear vision before the baby is able to adjust his visual focus to objects at varying distances; he acquires accommodation first in following it as it withdraws, and his focus is led on farther and farther in watching people as they come and go. He acquires his conceptions of distance and size and direction mainly by this same road. By learning to recognize his friends when their faces are turned away he first comes to an understanding of the identity of objects in their different visual aspects. When he begins to use touch also to investigate objects, nothing attracts his curiosity oftener than the faces of his attendants, which he explores with hands and mouth in every possible way. By the association of voices with the face, he gets his first auditory idea of direction. The face is the first visual object recognized; the voice the first sound, unless, it may be, instrumental music. From his perceptions of the different effect when he touches another person and himself, from his observation of the same movements, unfelt in them and felt in himself, comes the final re-enforcement of his bodily self-consciousness.

Of the further intellectual and social education that comes to him through human association, I do not speak here. But even in the matter of sense development only, the human environment is the one thing of importance.

Here nature herself has provided the best education. The mother, bending over the child with constant care, with instinctive prattle and gentle touch, is bringing the senses into effective co-operation, organizing the whole association system, more swiftly and surely than any possible system of forms and motions displayed before his uncomprehending eyes, could do. All the mother's foolish instinctive play with the baby, the rolling over, kissing, cuddling, cooing, ducking her head into his bosom, her songs and lullabies, the baby's unchecked liberties with her face and hair, are giving him the best possible material for intelligent use of his senses. It is a matter of easy observation that the baby who is left lying on the bed alone a great deal, no matter how well cared for physically, does not develop as brightly, and learn to use his senses happily as soon, as the baby that is cooed over and played with.

2. SECOND STAGE: VISION AND MANIPULATION.

Provision of Stimulus.—With the development of grasping comes a period at which the natural environment is not sufficient to meet the needs of the expanding faculties; or, to put it more truly (and most literally), the child is not able without help to get at and lay hold on his natural environment. The helplessness of the human infant,—necessary as it is to his ultimate high development,—compels him to sit waiting to have the due food of mind and body brought to him. If the baby is to come to grasping, he must be supplied things to grasp. It is true that he will learn in any case,—the folds of his clothes, the fingers of his attendants, will answer for material. But with material so insufficient in variety and convenience, grasping will not pass through its normal stages of development; it will come as a "deferred instinct," all at once, when the full time has arrived. In that case, the movement will be acquired, it is true, but the lessons in space perception, the slow and sure fusion of

eye and hand knowledge, the educational value of the more gradual development, are impaired; they have to be learned in belated fashion afterward, if we may judge from the blundering and insecurity that is shown in the grasping for a long time, as if the associative network between the cerebral centers were insufficient (p. 112, and Preyer, *op. cit.*, p. 249).

Most mothers are neglectful of providing soon enough the objects for grasping. It is taken for granted that children do not need playthings till they can play with them, which is much like keeping them from the water till they can swim. Indeed, in many a home one may see babies, otherwise tenderly cared for, sitting with nothing in their hands or within their reach, fretful for lack of occupation, long after they have learned (by meagre chance opportunities) to grasp, and every moment is precious for the manipulations and mouthings their senses are craving.

The appearance of successful efforts to carry the hands to the mouth, the fumbling of the fingers on a surface that they touch, the closing of the hand with a newly firm and conscious hold on objects laid in it,—these are the indications (appearing about the third month) that grasping, with its immeasurable psychic results, is at hand, and the baby ready for material to practice on.

But it is still futile to think of education through any system of presenting the spectrum colors and the geometric forms as playthings. It is not certain that the child even sees the colors, especially the cold colors, at this date; it is certain that he does not attend to and discriminate them, and that he cares little for them. The difference between the several solid forms is not easily perceived, even far on in the second year. In the early period of grasping, the simplest sensory feeling of solidity, probably even of objectivity, is yet in the forming, and the difference between sphere and parallelopipedon is merely a question of which is easiest to lay hold on and get into the mouth. The brightness of an object (not its color); the rattle or jingle that can be obtained from it (for sound-making processes already interest); its resistance, weight, and movability; its identity in all its different visual and tactile presentations; the mere fact

of its solidity, its extension in space between the surfaces on either side which he touches and sees; the difference between an object thus seizable, and a plane figure; the nature of the surface, smooth or rough, hard or soft,—these are the things the baby must be occupied with for many months, before he can comprehend form or color. The important thing, therefore, is that the objects given him shall be convenient to grasp and to suck, shall offer a good firm resisting surface for him to feel against his palm and gums, and, shall be such as he cannot harm himself with. Some jingling or rattling adjunct for the ear, some bright silver or nickel adornment, or black and white contrast, a good cylindrical grasping place for the hand, a convenient tip for sucking, meet all needs well enough.[1]

From this time, the more fully every desire of the baby's to touch, feel, pull about, and mouth everything he can lay hold on, can be gratified, the better. The best educated baby will be the one kept in an environment where there is least that can injure him or that he can injure, and allowed to investigate to his heart's content. The wisest mothers even give the baby much that he could injure or be injured by, and then keep vigilant guard, rather than check his inquiry. It is mainly a question of how much trouble the mother is willing to take for the baby's good. Is willing, I say, not is able, for I have not observed that the busiest mothers are the ones who find it hardest to take the time for this attention to their babies.

Restriction of Stimulus.—At this stage of the child's development a danger becomes serious, which exists even earlier,—from the time a baby can first be played with and entertained at all.

[1] These are easy requirements. A silver spoon, a few empty black and white spools or large wooden or bone beads strung on a strong tape, a bit of bamboo with sliding rings, any slender shaft of smooth wood with a good conical end—such things are better than nine out of ten of the elaborate rattles offered in the stores. I am not convinced that the baby really cares for the rattling adjuncts; he seems to prefer getting sound by pounding objects on the table, or banging them against each other, and he has always a sound-making organ superior to any in his own throat, and by these other methods he can observe the sound-making process better than by shaking a rattle. However, I am not prepared to criticize the practice of all times and races in the matter of the rattle, and it does no possible harm.

That is the danger of over-crowding stimuli upon his attention. One must draw the line between neglecting to provide needed stimulus, and over-stimulating. It is by no means a difficult or delicate line to observe in practice, for it is perfectly easy to see when a healthy, normal baby is being over-stimulated. Indeed, at this age, a baby will himself draw the line, and only folly in the parent will coax him over it. As soon as his attention is called from object to object, before he has exhausted the interest to be found in each,—as soon as he is confused by the number of objects of interest, and distracted from one to the other, he is going over the limit of his mental good. It is a good old nursery rule never to divert the attention of a baby who is occupied in looking at or playing with anything, lest his power of attention be weakened. Babies suffer on the one hand from the sheer selfishness of those about them, who recklessly make playthings of them and break into their self-activity; and on the other hand from the sheer neglect that fails to provide them material and opportunity for self-activity. This neglect commonly befalls infants who are cared for by servants, however faithful and prudent.

The secret of happy and wholesome development in the early years seems to be mainly in giving the largest possibility of free action. Nothing is more conspicuous in my record than this. The remarkable hatred of restraint; the intense joy in free activity; the busy energy with which when left to herself the child would pursue her own education,—all show nature, up to a certain point, doing better with the development of senses, muscle, and mind than any outsider could do, and requiring only such help as the baby's own helplessness in laying hold on material made necessary. And to secure to a child the largest freedom of activity possible is by no means easy and simple, for it is a different thing from simply letting him run, uncared for; it sometimes involves much more trouble than restricting him narrowly; he must be companioned, co-operated with, "lived with," incessantly. But the results are worth it.

3. THIRD STAGE: BEGINNING OF INSTRUCTION.

Limitation of Purely Natural Development.—Up to a certain point, I said above, nature can do all that is necessary, if opportunity and material are provided. But the time comes, gradually throughout the second and third year, when nature alone is not sufficient. It should be evident that the instinctive unfolding of the child's powers will go no further than to put him into possession of those race traits that have become firmly infixed in us by long ages of inheritance. Even when it comes to so old an acquisition of the race as speech, the baby will not acquire it by pure self-unfolding, as he acquires seeing and hearing and grasping; he must learn it by imitation. When it comes to the attainments of civilization, even imitation is not enough. Tasks must be set, and efforts must be made.

Bearing of the Recapitulation Theory.—A smattering of the recapitulation theory leads mothers (and, unfortunately, physicians, who approach the subject from a physiological rather than a psychological point of view) to set down the child as "only a little animal" during the early years of his life, and in no need of human education.

One is quite misled by the ontogenic and phylogenic parallel, if one supposes the senses or the mind of a baby are really those of a lower animal. He comes into the world with an apparatus of sense and of intelligence that have long before birth diverged from the pre-human type. It is undeveloped, but not of low order. The infant's brain at birth, for instance, according to Donaldson, has its full number of cells. It has, as Flechsig shows, the same sense-centers, the same vast and elaborate system of sensory and motor and association paths, specialized to the same purposes, the same great tracts of association or "intellectual" centers, as an adult, and such as the most intelligent of the lower animals does not remotely approximate. The cells and neurons are simply unripe, not yet in function. They come into function roughly in the order of their racial antiquity, and therefore in an order that repeats roughly the phylogenic. But the order is broken into in a thousand ways; and at best, the parallel is only a parallel, not an identity. From the first, a

purely intellectual sort of impulse makes its way into the baby's processes, and makes them unlike those of the lower animals.

Compare the behavior of Dr. Kinnaman's monkeys toward color with that of a baby who might be supposed to be at about the same general stage in the development series. The monkeys were perfectly able to discriminate all the colors, but they had not the slightest interest in doing so until their dinner depended on it. Mrs. Tilley's baby boy, in his 15th month, seeing a blue dress thrown on a lounge, toddled up to it, and panted and smiled with pure excitement and joy over the sense experience,—an experience that had for him no relation to any life-preserving activity. Many lower animals show as much intelligence as a baby in the second year; but in how different a spirit! Can any one imagine a dog bringing a letter on a block with interrogative grunts, wishing to have it named and ticketed off among his apperception groups? or an elephant puzzling himself over the damping of a sound when a hand is laid upon a glass that a spoon is tapping? An immense excess energy, over and above life-preserving needs, and flowing into the development of the great human associative centers, makes the infant's cerebral action of a type utterly unlike the lower animal's, even though it follows in some sort along a parallel line in the obvious stages of development.

It is on this excess energy that education builds. In this lies the possibility of catching up, so to speak, by cross cuts, with thousands of years of race attainment. The child must make these cross cuts, if he is to become a civilized man; if he is to become a highly civilized one, he must make them with the least possible waste of time and energy. As soon, therefore, as the rapid development of the association centers begins (comparatively plastic as their order of development is, not rigidly fixed by primeval inheritance), the problem of education begins, in directing that development. Even if the child were actually a lower animal or a savage, he could not wholly dispense with lessons. The very cat teaches her kittens, with every appearance of purpose, with cuffs and rewards,—as any one may see who will watch her awhile; and the parent birds hurry on their nest-

lings with lessons into the instinctive activity of flying. Much more should the human mother refuse to be frightened by pedagogic theorists out of teaching her nestling its little lessons, such as in her opinion will best prepare the way for the mastery of the great accumulations of the world's knowledge. She herself, with her close intimacy with the child, is the best judge of the extent and content of the lessons; she needs only to start with the full assurance that in calling the mind into guided action, instead of "letting it run wild" she is doing the normal thing.

Limits of Instruction.—It is but in the slightest degree that any formal education can be begun, within the first three years. For the most part, all that has been said of the second period holds good in the third. The largest freedom of activity possible, is still the rule,—the child's own self-chosen play, watched over and cautiously aided, without too much suggestion, or too much apparatus. It still remains true (as indeed in all later education) that the Scylla and Charybdis between which one must steer are the danger of breaking up and shallowing the attention through urging it with rapid and changing stimuli, and the enfeebling it through insufficient demand. The danger is never especially great of overtaxing the mind,—vigorous exertion and normal fatigue is as wholesome for brain as for body,—but of fatiguing it by frittering its powers and pulling it this way and that; amusement and excitement, provided from the outside, so to speak, and not obtained by the child's own exertion, are more dangerous and exhausting than a quiet, steady mental tension.

Along the lines of his own choosing, a child even in the second year will show a good deal of capacity of mental tension. By watching him, all through the second and third year, experimenting along the lines of his own interest, being wary meanwhile of any very firmly formulated theory of infant education, but well possessed by high ideals of the future education toward which these first steps are to tend, the mother can accomplish by gentle degrees, and with real enhancement to the happiness of the little one, a wonderful deal toward starting him well on the long road of formal education.

Special Suggestions.—In the few unsystematized suggestions that follow (let me repeat), there is no attempt at anything like a scheme or system of sense-training; nor any attempt to cover the whole ground. They may perhaps be taken in the light rather of illustrations of the sort of educational beginnings that may wisely be made, feeling one's way along the lines indicated by the general principles that precede. I set them down in chronological order.

1. The earliest direct sense training which the mother will attempt is in most cases that of the ear for the enjoyment of music. Indeed, this may in a sense date far back of the "third period," to which I have assigned the beginning of deliberate sense education, for music gives the baby a simple sensory pleasure from the first month of life. Results from hearing it, in the way of musical development, are much later, and vary greatly with different children. In all cases, however, something is learned of rhythm and pitch, and the habit of enjoying music is formed.

The teaching of rhymes and jingles, in the latter part of the second year and during the third, is a good adjunct in the teaching of rhythm. Now and then a child is found who can catch simple dance movements within the second or third year.

2. At some time not far from the close of the third quarter-year, the child becomes capable of enjoying pictures, and of relating them in his mind, in some fashion, to the objects represented. It is a highly educational pleasure, and the child should have it as soon as he is able to use it. As the time approaches when he could be expected to care for pictures, they should be supplied, but not especially urged or explained; and he will do the rest. It is possible for injudicious parents to do harm by amusing themselves with showing the little one pictures in great number and rapid succession. A few familiar pictures, well looked at, over and over, each one as long as the baby will (no matter how bored the parent may become) are far more educating than many new ones hastily looked at. The parent should watch the child and introduce new material slowly, from time to time, as she judges it can be taken up into the mental life

without confusion. The child will to some extent regulate this himself, refusing to take interest in novelties that he is not yet ready for, and going back to the same old pictures; but it is possible to break down this wholesome condition in him, and teach him to crave new sights perpetually.

Looking at pictures belongs especially to the second year, and will probably prove an occupation of much (though intermittent) interest, throughout the whole of the year. Most of the evidence is to the effect that clear black and white outline is more satisfactory than color, but let both be tried, by all means. The possibilities of real systematic education that lie in the selection of subjects,—the acquaintance with animals, with domestic life, processes of labor,—will occur to every parent. If acquaintance with the picture can be followed up regularly by the sight of the object itself, the educational effect is much greater. This however, carries us beyond the subject of mere sight-training.

3. The ability to recognize all the simple plane figures is certainly present by the middle of the second year, and if language development is advanced to the average degree, the child may easily be taught to distinguish them by name. They may be taught him by pencil-drawing, by stick-laying, by clipping out paper forms, or by use of the cardboard tablets found in kindergarten supply establishments. It is not a bad idea to use all these methods, and so help the child to generalize the form idea. If my experience is typical, it is worth while to teach these figures, for the sake of the lively attention it awakens to varieties of form in the world of surrounding objects.

4. There is no difficulty at all at this stage in teaching those particular plane forms that make up our alphabet, and the Arabic figures. It is a striking tribute to the influence of Rousseau that a curious and unfounded reluctance to allow the child to learn this particular set of names has become widespread, displacing the old practice of our grandparents. The child, playing with his letter-blocks, is often curious to know the names of the symbols, and in any case picks them up with great ease if he is taught,—for he is in the very heart of the nascent period in learning to attach auditory symbols to visual objects; later,

the attainment costs him more difficulty, and is more tedious to him. It is a great convenience to later teaching if the baby can pick up a good part of his alphabet during the second year, in the course of play with blocks or cards, and I am satisfied that no mother need have the faintest scruple in teaching them.

5. The discrimination of colors, down to distinctions as fine as any adult would make, can be taught sometimes in the latter half of the second year, always by the first half of the third year,—not with as much ease as plane figures, but still without great trouble. It is by no means necessary to use such elaborate and laborious methods as in Professor Preyer's experiments and mine, since we were trying to get statistical results; a little care taken to show colors and name them a few times to the child would probably be sufficient. But the child may perhaps find it easier to get the different color categories clearly defined, and to assign difficult intermediate tints rightly, if standard colors are used in teaching, instead of any colored objects that chance to be at hand.

When he is able to learn the colors in the second year, it is a better time than the third; for during the nascent period of name-learning, the simple exercise of attaching its name to each color delights him, while in the third year, when the interests are more complex, it is apt to bore him. This, of course, depends much on the degree of advancement in language. I found that familiarity with colors opened up to the child a source of great pleasure in observing color in the world about her (just as in the case of the plane figures), and the effort of the attainment seemed amply justified by this.

6. The solid forms can be taught, without costing the child any real difficulty, at perhaps two years old or in the third year; but they do not rouse much spontaneous interest. The indifference to them, and the confusion shown in understanding their properties and their relation to planes, throws much doubt on the wisdom of making them an important keynote of sense education. Certainly they cannot be utilized much in the first three years. If it is intended, however, that the child shall enter kindergarten at three years old, and shall be taught during the

next period of life on kindergarten lines, there can be no harm at all in introducing some simple knowledge of these forms in the third year, by way of leading up to the kindergarten course.

As to the pedagogy of the other senses, I have little to say. No doubt both taste and smell could be trained to greater discrimination, but there seems no reason why it should be done. The inhibition of irregular desires is rather the way in which taste training should tend, and so far as I have seen, children show very quickly the effect of such training. The education of the muscular sense that is given in connection with motor training; the remarkable pedagogic possibilities connected with the peculiar states of general sensation and then of emotional susceptibility in the borderlands of sleep; the several lines of early teaching that lead the child to more complete definition of the bodily self,—these all belong more conspicuously to other subjects than to that of the Senses. For anything more that concerns the pedagogy of the unspecialized senses, I will only say that all observations point to the largest possible outdoor freedom of bodily activity, with good health, as the condition of a felicitous state of organic and general sensation, and all the fortunate results in temperament and healthy emotional experience that follow thereupon. To secure to the child this large freedom, under the very best conditions of vigilant companionship, means lavish devotion of the mother's time and care.

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NOTE.—This is an index to the author's Notes on the Development of a Child (1893-1899), as well as to the present volume. References to the former volume (University of California Publications in Education, Volume I) are indicated by the Roman numeral I preceding the page number. The numeral IV indicates reference to the pages of the present volume.

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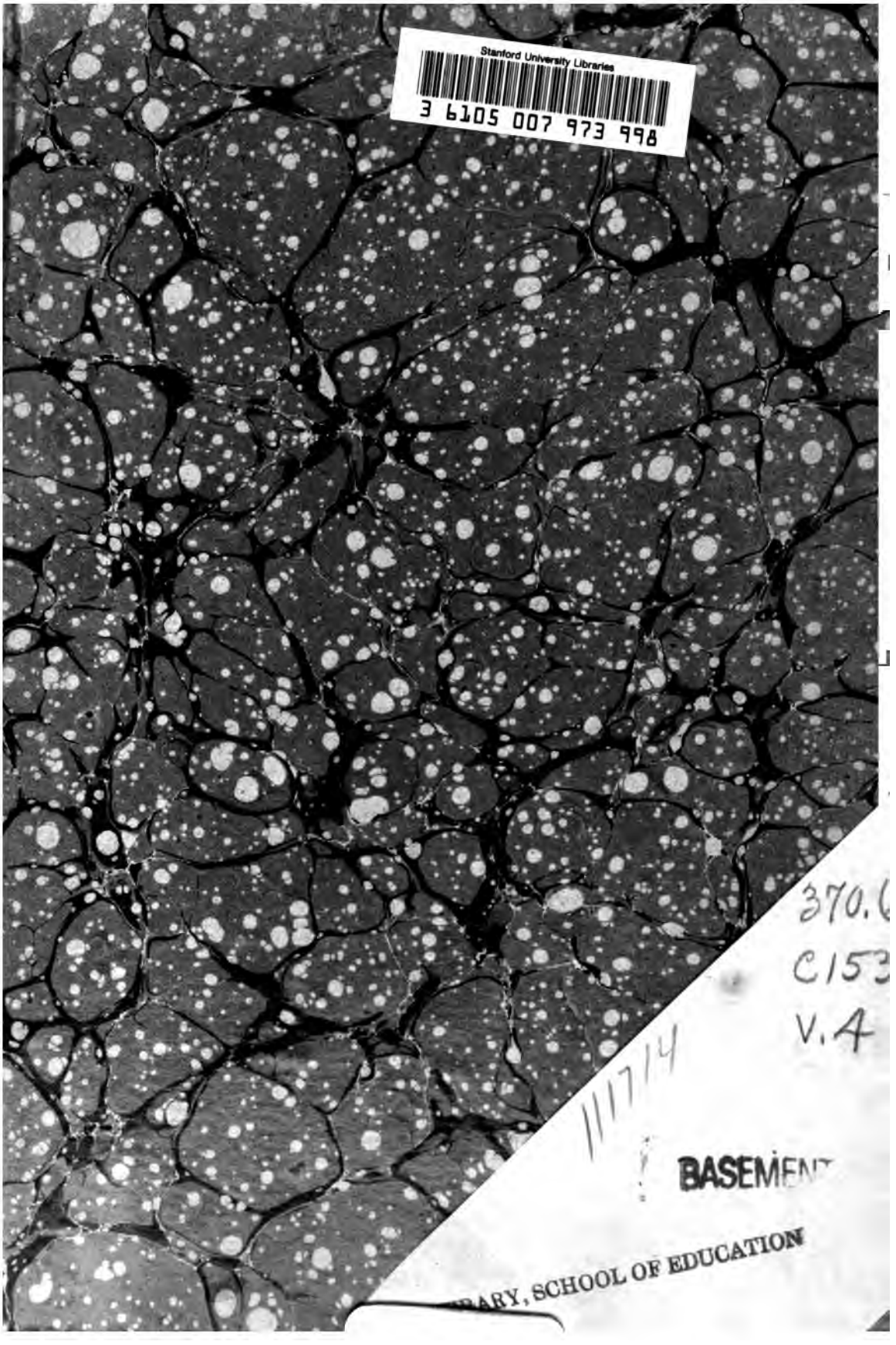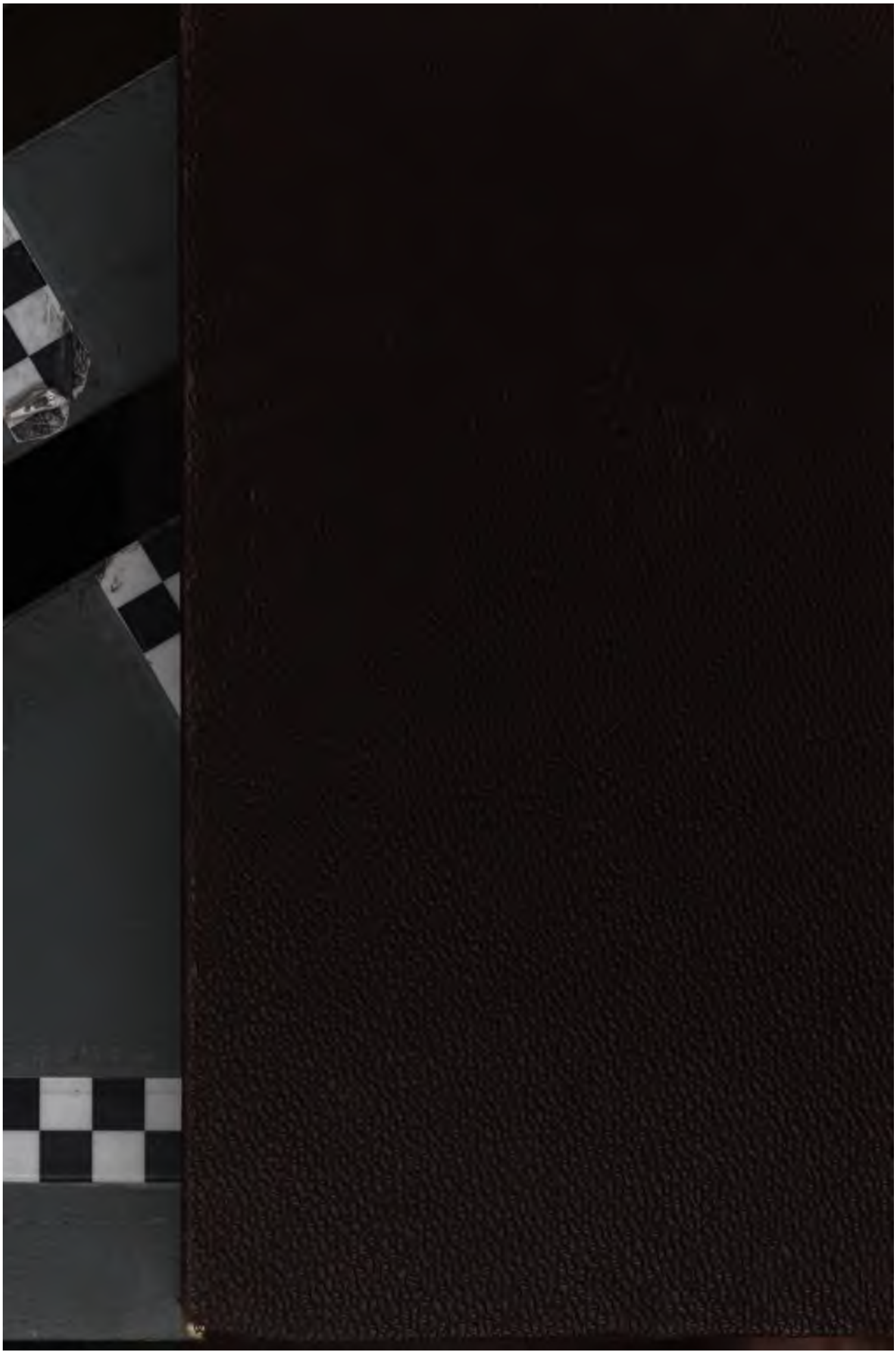
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